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Volume XVIII September, 1955 No. 3

CONTENTS

IN FUTURE NUMBERS 81
WITH THE EDITOR, 1935 83
AMERICAN DEMOCRATIC SOCIETY AND THE SECOND INDUSTRIAL REVOLUTION 84
Clarence C. Walton
AN EXPERIMENT IN SCHOOL CHILD HEALTH CORRECTION 87
William C. Mather
NUCLEAR RESEARCH WITH HIGH-ENERGY X-RAYS AT IOWA STATE COLLEGE 88
L. Jackson Laslett and Daniel J. Zaffarano
CONCEPTS AND TECHNIQUES IN TEACHING THE ORGANIC CHEMISTRY LABORATORIES 92
Arthur Furst
SCIENCE TEACHERS AS COUNSELORS 94
John Stratton
THE SCIENCE OF MODERN HOUSEHOLD LAUNDRY APPLIANCES 95
O. H. Doutlick
THE EARLY HISTORY OF CHEMICAL LABORATORY INSTRUCTION 97
Paul Walden
THE STAFF OF LIFE 101
William B. Bradley
RELIGION AND SCIENCE AGAIN 103
Brother I. Leo, F.S.C.
NEW BOOKS 119

In Future Numbers . . .

Among the articles planned for publication in the near future are:

Silver Springs and the Balanced Aquarium Controversy
By Howard T. Oddum and James R. Johnson, Department of Zoology, Duke University, Durham, North Carolina.

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HUGH C. MULDOON, Ph.G., D.Sc., D.Litt.

Founder and Dean, School of Pharmacy, Duquesne University
1925 - 1955

Founder and Editor, Science Counselor
1935 - 1955

DEAN HUGH C. MULDOON — Founder and editor of THE SCIENCE COUNSELOR for its first nineteen years, retired from academic life and his editorship of this journal in June, 1955.

On the opposite page we have reprinted Doctor Muldoon's editorial from volume one, number one of THE SCIENCE COUNSELOR. We have reprinted it as a pledge of our determination to strive for the same objectives for which our founder not only strove but successfully fulfilled. We feel that we need add nothing to this first editorial except to say that we will use it as a chart for our course.

With the Editor, 1935

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THE SCIENCE COUNSELOR is a journal of teaching methods and materials for instructors in science at the high school level. Its title tells its purpose.

There are now many excellent teachers of science in the Catholic secondary schools. The courses they conduct are already admirable. But every teacher will agree that there is no high school—or college either for that matter—in which instruction in science cannot be improved.

It is recognized that teachers of science in the Catholic high schools often work under great difficulties. Undoubtedly there are times when they would appreciate friendly encouragement, advice, and direction. They would be gratêful, too, for an occasional stimulus to their enthusiasm which naturally flags at times. Teachers are always striving to increase their knowledge of their field of specialization. They realize that their educational horizons should be progressively enlarged, for their work demands breadth of learning as well as depth. Up-to-date an authentic scientific information must be sought constantly. Teachers of science should be encouraged to test new and different methods of instruction. They will gain much by learning what other science teachers are doing. In their turn they should give to others the results of their own experience. In this way it should not be difficult to arouse a group consciousness and a cordial spirit of cooperation. THE SCIENCE COUNSELOR hopes to help in this work. Its pages will provide a convenient medium for the exchange of information and for the discussion of teaching and administrative difficulties.

Science moves fast. Teachers in service find it difficult to keep up with its advances. Time, facilities, finances are limited. There are many conscientious high school instructors who may not be acquainted with the latest and most important books in science and education. They may not be in touch with recent researches. They are sometimes unaware of the many helpful articles that appear in the current literature. They may not know where to obtain information and materials that could be of service to them in their work.

High schools are not elementary colleges. High school science should never become again what it once was, condensed and abbreviated college science. Modern high school science has aims and objectives of its own, quite different from those of college science. The needs of young people of high school age are not met, and their interest is not stirred, by college science, with its rigid, formal, and abstract didacticism, its logical groupings, its highly technical terminology, its emphasis upon laws and principles, its stress upon laboratory work and the technique needed for research, and its general aloofness from the things that seem important to adolescent youth. Too frequently, however, the instructor fails to appreciate the situation. Unthinkingly he offers to his classes his own college courses, almost identical in material and method, but in an attenuated form. Surely such a teacher is not aware of the developments that have taken place in his field during the past decade.

Some instructors who are well informed in the sciences fail because they continue to use antiquated and unsatisfactory methods. All teachers, of course, want to teach well. Some are more successful than others. The successsful ones are those who realize that good teaching doesn't just happen. It must be striven for, prepared for. Good teaching is planned teaching. It is an art rather than a science, but there is no reason why the methods of good teachtrs cannot be analyzed and studied and adapted to the needs of those who are less successful. Methods in themselves are of little value. Every method, regardless of its worth, requires a real teacher to make it effective. Good methods can make a better teacher out of a good one; they can make the difference between success and failure for the beginner. Teaching methods in any science should be as modern as the subject matter.

THE SCIENCE COUNSELOR hopes to help teachers by bringing to them authentic scientific information before it reaches the textbook stage. It will call attention to modern and successful teaching techniques. It hopes to give its readers a progressive point of view; to inspire them to a careful and scientific study of their own problems; to encourage them to analyze and improve the teaching methods they use every day. The staff of this magazine will be glad to help them to cooperate in solving their common problems and to assist them in evaluating and applying the results of researches. The combined efforts and resources and influences of the teachers of science in the Catholic high schools can be both powerful and productive.

This journal will not be in any sense provincial. Its scope will be national. Among the contributors to its columns will be teachers and administrators in the public as well as in the Catholic high schools, experts in science and in teaching, and instructors and executives drawn from numerous colleges and universities throughout the United States. THE SCIENCE COUNSELOR cannot accomplish what it plans to do through the efforts of any special group. All must help. The aid of everyone who can assist in making it a better and more practical journal will be most welcome.

The success of THE SCIENCE COUNSELOR rests in the hands of the hundreds of teachers of science in the Catholic high schools of the United States. The Editor believes that their response will be cordial and immediate. ●

American Democratic Society and the Second Industrial Revolution

• By **Clarence C. Walton, Ph.D.,** *(Catholic University)*
DEAN, SCHOOL OF BUSINESS ADMINISTRATION, DUQUESNE UNIVERSITY

Scientists and Business Men are too frequently looked upon as materialists. Dr. Walton, dean of a school of business administration, points out to a group of science teachers the role of science in our society.

This paper was delivered as a special lecture at the Science and Mathematics Institute Day of the Pittsburgh Diocesan Science and Mathematics Teachers Association at Duquesne University in March, 1955.

Students, teachers and scientists should profit from a careful reading of Dr. Walton's message.

●

It was November 1, 1932, when my father and I took what retrospect was eventually to impress upon both of us as a memorable walk. It was an easily remembered day in an easily remembered year for it was the feast of All Saints and that meant a holiday from school; and it was a particular time in a momentous year because a dynamic politician named Franklin Roosevelt was finishing a whirlwind campaign against President Hoover with brash prediction of an electoral landslide for the Democratic party. As was our custom, this evening promenade traced a large arc which eventually led to a high ledge whence we could catch a magnificent view of the 8:15 coal train as it chugged westward toward Chicago. It was a perennial source of fascination to behold the three mountain locomotives, assisted by a "pusher" in the rear, hauling the long line of coal cars up the steep mountain grade. Pistons moving in agonizing yet poetic rhythm, boilers heaving with exertions, flaming cinders belching skyward, steam hissing into the cold night—all combined to create a picture of sound and fury and majesty. As we watched the train disappear into the night my father observed, half wistfully: "You know, Son, that our good coal is being rapidly depleted and some day when coal goes so goes our beloved America."

The Second Industrial Revolution

On that day in the year 1932 my father's commentary seemed eminently reasonable. For coal had ushered in the first industrial revolution; coal had broken the long tradition of man's dependence on slave power and on beasts-of-burden. All societies from Nineveh down well nigh to the time of Washington were handicraft cultures with little help from inanimate sources of energy. Coal changed all of this and so it was inevitable to my father and his contemporaries that "as coal goes, so goes the country!"

The train of which I spoke was bound for Chicago. In that very city a decade and a month later, (December 2, 1942) a few men gathered beneath the field-house of the University of Chicago and successfully gave the first demonstration of a self-sustaining nuclear chain reaction. The atomic age was born and the physicists assured us that, from the fissioning of one pound of a particular form of uranium in an atomic reactor, energy roughly equivalent to that of 1300 tons of coal could be obtained. Almost overnight the question whether King Coal lived or died seemed a matter of indifference. A new monarch reigned over the realm of energy to help mankind take a gigantic step toward even greater material advances.

Inasmuch as material progress depends on increased food production as well as on increased production of energy it appeared that an imbalance might be developing unless the former could be sharply accelerated. In this context the announcement made quietly at the annual meeting of the Association for the Advancement of Science on December 26, 1954, that the problem of photosynthesis had been solved assumes tremendous historic importance. For the chemists from the University of California were telling us that it was now distinctly within the realm of possibility to produce food directly from the sun's energy without the necessary intervention of plant or animal life.

Sandwiched between these spectacular developments in energy and food production techniques was another which profoundly affected the means of running our industrial machine. In 1952, Dr. Claude E. Shannon of the Bell Telephone laboratories, introduced Theseus, the mighty mechanical mouse with the electrical brain. Theseus could be set down anywhere in a labyrinthine maze he had never before seen. By repeated trial and error he would find his way to a magnet. If he was then put down again at any point of the labyrinth he would swiftly retrace the shortest route to the magnet, by-passing all dead ends. This little robot rodent has already become a figurative lion in learned societies. The wire in his whiskers, the electrical switches in his brain, the bar magnet which is his backbone, and the wheels on which he travels, have become the collective symbol of a machine's capacity to duplicate reiterative practices man has employed over generations. And what does Theseus represent? He is the mighty-mouse symbol of automation, the technique which suggests to many the advent of the long heralded push-button civilization.

Atoms, automation and photosynthesis are, therefore, three of the major ingredients in this second Industrial Revolution. What they imply for the coming decade

is hard to imagine but we who have seen the horse replaced by tractor, the pick-and-shovel by the power scoop, the wheelbarrow by the bulldozer and the street-car conductor by the hydraulic door hinges on a bus can at least take appropriate pause. Today's accomplishments are the prologue for our new drama. Already Theseus has been dwarfed by newly conceived giants with electrical brains which can do phenomenal things. Fosdic, who works for the United States Census Bureau, can read forms submitted by census-takers, pick out the right information from corresponding columns, add five million answers in a half-hour and file it away in a microfilm library. And Fosdic, in turn, is merely a little brother to Univac who is doing prodigious things for United States Steel and Westinghouse.

Even at this early hour the harvest from these technological achievements is enormous. From the atom we are getting radioactive isotopes which promise so much in dealing with cancer, heart ailments and arthritis and which offer so much hope to the older segments of our populations. Regarding the production of atomic energy Palmer C. Putnam, consulting engineer with the AEC, estimates that there is enough uranium and thorium already in sight to provide the world's energy needs for the next 1,700 years and at the rate of energy consumption estimated for 2000 A.D. We can provide enough energy not for yesterday's two billion population but for some fifty to seventy billion human beings. When the cautious scientist is emboldend to prophesy is it any wonder that the layman grows giddy at the material promise the future seems to offer? Perhaps the easiest way to assess current situation is to recall our own student days when a good deal of time was spent studying Malthus' observation that population tends to outrun subsistence. This second Industrial Revolution literally reverses the famous Malthusian formula. We are being offered a range of choices of material living beyond the wildest dreams of yesterday's utopians. Instead of making a choice to save money for the college education of his children or for going to Florida on a winter holiday the worker of tomorrow may confidently expect to do both. For the first time in recorded history a great population concerns itself not with the problem of living but of what kind of life they want. It is a question of choice and since it involves human wants and desires it involves human will and human reason. Neither Fosdic nor Univac will help us in this critical area of selection.

Emergent Problems of the Second Industrial Revolution

How man handles himself and the material plenty he creates becomes increasingly important since every technological improvement results in a novel set of unexpected problems. A short commentary on existing developments is enough to sustain the point. For automation to increase industrial efficiency is a highly desirable achievement; for automation to create even short-run social maladjustments can be quite another reality. Why did Phil Murray campaign during his final days for a thirty hour week? Why did Walter Reuther during the 1954 negotiations between the United Automobile Workers and the auto industry cut the duration of contracts from five to two years? Why the hue and cry over guaranteed annual wages? The only possible answer is that some union leaders feel that the number of displaced workers will be considerable; that they share the dim view of Norbert Weiner who declared flatly (in his book, *Cybernetics*) that the new revolution is destined to devalue the human brain just as the first industrial revolution devalued the human arm. Perhaps the skilled man may get by but "taking the Second Revolution as accomplished, the average human being of mediocre attainments or less has nothing to sell that is worth anyone's money to buy." We are moving toward a unique situation in American industrial evolution where the machine will be asked to subsidize the workers it directly replaces.

The area of atomic developments has produced its own complex of dilemmas and our gyrations in the area of foreign policy neatly serve to illustrate the point. In January, 1954, the American Secretary of State first expounded the doctrine of "massive retaliation," a doctrine obviously premised on the belief that our advantages in atomic weapons were so formidable that we could contemplate using them against Russia or China if either resorted to aggression. But that was before the three hydrogen detonations during the summer. The destruction at Bikini was evidently so fearful —not to mention the potential horrors of "fall-out"— that in October of that year President Eisenhower clearly blunted the edge of Dulles' main point by flatly stating that "there is no longer any alternative to peace." Any leverage we might have assumed from superiority in atomic weapons was being relinquished. Should this appear too extreme a conclusion a close examination of American policy during the crises over Indo-China and Quemoy proves enlightening. Not once did we threaten to employ massive retaliation during those critical days!

More disconcerting than any destruction which atomic war can cause is the fact that no matter how amenable the Russians may grow, the road to disarmament seems effectively blocked. Security based on disarmament looks at the moment like a lost cause. "The technical feasibility of atomic disarmament," Eugene Rabinowitch, the editor of the *Bulletin of the Atomic Scientists*, wrote recently, "now depends on reliable inventory of existing stocks of fissionable materials. Considering the extremely small bulk of these materials, and the absence of penetrating radiations emanating from them, the only possibility of inventorying them is for the agents of the U.N. control body to be led to their stockpiles by national officials who know where they are located. Neither the West nor the U.S.S.R. can be expected to base its own atomic disarmament on the trust that the other side has not concealed a substantial part of its stockpile. . . . If this conclusion is true, then we must add to the appalling knowledge of the material and biological damage of a future atomic war the sad recognition that effectively controlled atomic disarmament has ceased to be possible and that all attempts to find a compromise solution are therefore bound to

remain futile. Mankind will have to live, from now on, with unlimited and unchecked stockpiles of atomic and thermonuclear explosives, piling up first in America and the Soviet Union, and then in Great Britain, and later in other countries as well." History threatens us with a cruel paradox in that we may soon look nostalgically at the comparatively secure days of the present Cold-War period; for in the future little Iran or Panama may send shivers down the world's spine with threats of sneak atomic attacks. If Rabinowitch is right this *dies irae* may not be too far distant.

Whence the New Leadership?

All the bewildering promise and threat implicit in the new industrial revolution poses a new challenge to Americans. Whether we concern ourselves with automation or with the atom we are faced with a difficult series of problems which forward steps in those areas have helped to create. The immediate and pressing need will be for more physicists, more mathematicians, more chemists and more engineers. Perhaps less pressing at the moment (but certainly more crucial to our long-range future) is the urgency felt for a kind of leadership which will have the wisdom and the prudence to use our increased power with creative and constructive effect. Turning out skilled technicians is one thing; turning out skilled statesmen is quite another.

Where will Americans find legitimate spokesmen? From what intellectual climate shall we secure leadership? An assessment of the first Industrial Revolution is highly instructive in this regard. The greatest single name in nineteenth century history (if we equate greatest in terms of influence exercised) was Charles Darwin. The appearance of *Origin of Species* in 1859 remains a landmark in intellectual history. When Darwin stressed natural selection through survival of the fittest in the struggle for existence he put physical man squarely in the midst of nature. His own innate caution (he always remained skeptical of natural selection as a key toward explaining social processes) was not enough to restrain certain of his contemporaries who labored in the social sciences. Walter Bagehot, for example, argued in his *Physics and Politics* (1872) that all social advances came through fierce struggles between nations, races and classes. Note well the essential ingredients of Bagehot's formula: struggle, survival of the fittest, and belief in inevitable progress. "Social Darwinism," as it was called, proliferated rapidly, and significantly, in the industrial nations of England and America. In its name and with an immense amount of pseudo-scientific jargon the inhuman exploitation of workers, of backward nations, and of races was justified.

Darwinism staggered the imagination of the intellectuals. At Harvard William James hastened the secession of psychology from philosophy by arguing that the psyche was no longer a soul but a biological process which allowed men to adapt to environment. The human mind becomes a *thing* rooted in materialism. In education John Dewey, falling under the same hypnotic spell of Darwinism, followed James by insisting that the mind was merely a refined instrument which enabled us to cope with environment in this struggle for survival. Into the rarefied atmosphere of legal philosophy moved Oliver Wendell Holmes Jr., who as a Justice on the United States Supreme Court, was able to reorient judicial thinking to the point of effecting a veritable revolution in our courts. To him law was merely an instrument of social policy which had- and needed- no other sanction than the backing of those who held physical power. In its nakedness Holmes' philosophy of law is so analagous to the Soviet conception of law as to become shocking but it should occasion neither shock nor surprise since both views are based on a sheerly materialistic philosophy of life.

This sublime faith in the accuracy and efficacy of Darwinism became all-pervasive. One of the venerated pioneers in the field of sociology, William Graham Sumner of Yale, identified morals with mores and since mores were relative it followed that morals were relative: What the group did today might be different from what the group will do tomorrow. But if the group acts in a significantly patternized mode then we have the emergence of mores, *sic*, morals—and mores or morals need no justification other than the fact that the group does it and accepts it. Shades of Kinsey!

What is the net importance of the movements herein so briefly delineated? The significance lay in this fact: that social scientists felt that to command respect, to be truly worthy of the scholarly titles, they not only must beg, borrow and steal from the physical sciences but that they must go further to promise the same kind of certitude. The heart of the social sciences is man's free actions. The only way for them to get physical certitude was to deny free will—and this they did with wanton abandon. In the process epistemology was assassinated. Is it any wonder that scar tissue still mars the noble face of truth? Or that many Americans, subconsciously at least, accept the very same postulates as Communists?

In hastening this survey violence has been done to history. The scrutiny, however, is designed to illustrate a point which is often lost to view. And it is this: that leadership in American society drew its inspiration and its claim to validity from the physical sciences which were then advancing at a dazzling pace. Students from other fields of knowledge—theology, philosophy, education and literature—who should and could have made substantial contributions grew timid in the face of the resounding successes achieved by the physical scientists. In a real sense they forfeited the game. It was not the avarice of the physicists or the biologists for power that brought them to power; it was either weaknesses and cowardice of others whose hurried exodus from the arena of combat left a void which others were called upon to fill.

Will the same thing happen in 1955? Will the artists continue to shrink and retreat? The preacher grow mute? The teacher fearful? The philosopher turn coy? Judging by the evidence at hand—and which is, hap-

(Continued on Page 108)

An Experiment in School Child Health Correction

• By William G. Mather
PROFESSOR OF RURAL SOCIOLOGY, THE PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA.

An effective school health program can do much to increase the general health of a community. Can the school health program be made more effective?

This article describes a project to obtain an accurate appraisal of such programs and the cooperation obtained from parents in correcting health defects.

●

Some 28 states, of which Pennsylvania is one, have systems of required medical and dental examination of school children. They are usually periodic—in Pennsylvania they are given each year to children in the odd-numbered grades. It is expensive, costing at least $5 per child examined. The results of the examination, if defects are found, are sent to the parent. The assumption is that the parent will then take the child to a private physician or dentist to have the needed correction made. School nurses may be employed to assist with the examination and to visit homes where necessary to encourage such remedial action.

While the school records of Pennsylvania have in general indicated an over-all decline, year by year, in the percentage of children found with health defects, there has been some dissatisfaction with the "correction" rate; and in 1952-53 research was undertaken by the Social Science Research Center at The Pennsylvania State University to determine if the percentage of children taken to specialists for corrective treatment could be increased. A grant of funds from Health Information Foundation was secured.

In brief, 20 public schools outside the larger metropolitan centers were selected and 1720 children in the third and fifth grades made the object of study. Five schools were made a "control" group and not experimented with; the other 15 were divided into three experimental groups.

As both law and custom make the nurse the key person in the contacts between school and parent, the experiment finally contrived was aimed at helping her. It was very simple.

School health records are usually kept in a file folder with the child's name on the tab, but nothing indicates the state of the child's health. Nurses use various ways of reminding themselves of this very important fact. The research team devised a six by nine card for each child found to need corrective action; one-half was for medical information, the other for dental. This data could be entered in appropriate places, together with the address, etc., and the nature and dates of contacts made with the parents. Across the top of the card were spaces where tabs, like those used commonly in libraries, could be attached. A red tab indicated that one or more defects had been found; it remained in place, projecting above the card in a highly visible way, until all defects had been treated. At this time, it was removed and a yellow tab indicated "all clear" and the case closed. Meanwhile, a blue tab moved across the top indicating the number of contacts made with the parents; and a black tab indicated when the family contacted a physician or dentist.

Kept in a box on her desk, this system gave the school nurse a visible check on the status of her charges at a glance.

All three experimental groups used this record card. One group used it only. Another added a class-room poster, recording pictorially the progress of the class toward corrective action (without using the pupils' names). The third of the experimental groups added to the card a program of radio and newspaper publicity.

Sixty to ninety days after the examinations, the parents of the children were visited and questioned as to what they had done about their child's defect.

There was very great differentiation between individual schools in the percentage of children whose parents had taken steps toward correction, just as there was very great difference between the schools in the percentage found to be in need of health correction. In fact, it first appeared that there was no order at all to either of these two important parts of the system —the finding of defects or the action toward correction.

Averages, however, cleared the picture.

The percentage of parents of children in the Control group who had contacted a physician was 46; that of all the Experimental group was 61, an advantage of about one-third in favor of the experiment. The additions to the use of the record card, as employed by two subdivisions of the Experimental group, appeared to make no advantage.

Corrective action for dental defects seemed unaffected by the experiment. Fifty-nine per cent of the parents of children in the same control group as above had contacted a dentist concerning their child's reported dental need, as compared to 60 per cent in the Experimental group. This may indicate that the dental problem is quite different from the medical one.

A surprising number of parents were already aware of their child's health defects before the examination took place. Forty-six per cent of the parents of children with medical needs reported to the interviewer that they had known the child needed care, and in fact, 41 per cent (of the 46 per cent) had their child under

(Continued on Page 114)

Nuclear Research With High-Energy X-Rays at Iowa State College

• By L. Jackson Laslett, Ph.D., *and* Daniel J. Zaffarano, Ph.D.
DEPARTMENT OF PHYSICS AND INSTITUTE FOR ATOMIC RESEARCH, IOWA STATE COLLEGE, AMES, IOWA

The use of "atom-smashers" to increase our knowledge of atomic nuclei has been widespread. A unique method of performing such studies involves the investigation of nuclear transformations induced by high-energy X-rays. In this article the authors describe the facilities and research program of the Iowa State College synchrotron laboratory, where for a number of years there has been a continuing research program to study nuclear reactions produced by X-rays extending up to 70 million volts energy.

Dr. Laslett and Dr. Zaffarano are associated with the Ames Laboratory of the U. S. Atomic Energy Commission.

●

During the past twenty years physicists have been artificially accelerating particles to high energies to produce nuclear reactions under experimentally controllable conditions. Such studies, motivated by the desire to acquire basic knowledge concerning the subatomic world in which an understanding of radioactivity and nuclear energy must be found, have stemmed from the pioneering researches of the group at Cambridge University associated with the late Lord Rutherford[1].

The accelerators employed in such research are of many different forms, commencing with the Crockroft-Walton generator[2], employing the Greinacher cascade circuit, and including the electrostatic generator or van de Graaff now available commercially in a well-engineered form for research and industrial applications. For the production of particles with energies above a few million electron volts*, machines such as the cyclotron[3] have been developed in which high particle energies are achieved by the repeated application of relatively small accelerating voltages. Research with the aid of such accelerators has resulted in much phenomenological information of value to nuclear physicists, the success being attributable in large measure to the controllable *versatility* of experiments employing such accelerators, as well as to the intensity of the beams available. It may be noted that the apparent size or "cross-section" which a nucleus presents to an approaching particle (as estimated from the observed probability of nuclear reactions) is typically of the order of 10^{-24} cm^2 and frequently smaller†, so that intensity may frequently be an important factor in determining the practicality of certain experiments. Although much has been learned by research of the type mentioned, much additional work remains to be done and it is desirable to approach the current problems by diversified methods.

Nuclear research which supplements in a useful and interesting way that performed with high energy particles can be undertaken by use of X-radiation. It will be recalled that the many diverse experiments which led to the growth of the quantum theory of radiation have established that, in the interaction with matter, radiation such as light or X-rays acts in discrete units possessing an amount of energy inversely proportional to the wave-length. With wave-length λ measured in microns‡, the energy of a quantum is given by

$$E = \frac{1.2398}{\lambda} \text{ electron-volts;}$$

it follows, therefore, that while photochemical processes involving a few electron-volts of energy per event can be produced with visible or ultra-violet light, photonuclear reactions would only arise with radiation of much shorter wave-length capable of transferring to nuclei energies in the Mev range. Gamma radiation may be employed in a limited way to produce photonuclear transformations, but X-radiation appears to have the greater utility for this purpose because of the greater intensities and the controllable range of energies obtainable from modern X-ray machines.

In following paragraphs we describe the general facilities and program of a research laboratory at Iowa State College designed for the study of photonuclear reactions. The central instrument of this laboratory is a *synchrotron*, capable of pro-

FIGURE 1. Aerial View of Synchrotron Laboratory. Control room, experimental rooms, and shop are in left wing. Synchrotron is located in right wing, and X-ray beam is directed to the right in the picture. Building is located about one mile west of Iowa State College Campus.

*The electron-volt (ev) is a unit of energy equal to that energy which would be acquired by a particle possessing the charge of one electron and permitted to fall through an electric potential difference of one volt. A million electron volts is a convenient unit in nuclear physics and is abbreviated Mev. By the way of example, the natural alpha particles which result from the radio-active decay of polonium (Radium-F) have almost exclusively the energy 5.298 Mev.

†10^{-24} cm^2 = 0.000 000 000 000 000 000 000 001 square centimeter, commonly termed 1 barn since on the nuclear scale a cross-section this large is considered "as big as a barn."

‡1 micron (1_μ) is one millionth of a meter, or one ten-thousandth of a centimeter.

ducing X-rays with energies up to 70 Mev, which was put into operation by members of the Department of Physics to serve as a research facility of the Iowa State College Institute for Atomic Research. The Institute, under the direction of Dr. F. H. Spedding, is an organization which cuts across departmental and divisional lines on the campus to foster a closely-knit research effort in areas of physical science. The Institute operates the Ames Laboratory of the U. S. Atomic Energy Commission. A major fraction of the basic research with the Iowa State College synchrotron—by staff, research-assistants, and other graduate students—is substantially assisted by research funds obtained from the Commission. The situation of a synchrotron laboratory within an Institute organization such as this one is particularly advantageous, since the instrument permits investigations of interest to physical chemists and engineers, and since the nuclear physics research can in many cases be materially assisted by the cooperation of workers from these other fields.

FIGURE 2. Synchrotron Experimental Room. Telescope is used to align collimators which shield detectors from direct X-ray beam.

The production of X-radiation is most efficiently accomplished by causing high-energy electrons to strike a target, which plays the same role as the tungsten anode of a conventional X-ray tube. The sudden changes of velocity experienced by the electrons on striking the target result in the production of X-radiation which contains quanta with energies extending up to the energy of the individual incident electrons. At high energies the conversion of electron-energy to radiation is highly efficient and the emitted radiation favors very strongly the forward direction. Machines for the production of high-energy X-radiation for photonuclear research thus basically are devices to produce high-energy electrons. Important types of accelerators for this purpose are the *betatron*, *synchrotron*, and *linear electron accelerator*, of which the first two involve the use of circular orbits to which the electrons are constrained by the use of suitable magnetic fields.

The betatron and synchrotron are in some respects similar in operation. Each uses a suitable magnetic field to guide and focus the particles within an annular evacuated region, the techniques of injection from a hot cathode are similar, and the final beam is produced in pulses. In each case the guide field must increase during the time the particles are accelerated, in order to steer the electrons successfully during the course of the acceleration. In the betatron the accelerating forces result from the electro-motance induced by a changing magnetic flux in a central core, the electron beam playing a role similar to that of the secondary winding in a conventional transformer[4]. In the synchrotron the accelerating forces are derived from radio-frequency fields which are applied at the appropriate frequency to deliver to the electrons an accelerating "kick" each time they traverse the R.F. electrode-structure. The elimination of the substantial amounts of magnetic flux required for betatron acceleration effects considerable economy in the design of magnets used in accelerators employing the synchrotron principle. The *stability* of particles in a synchrotron with respect to the phase at which they traverse the R.F. structure represents the key to the successful application of this principle and it is noteworthy that this feature apparently was recognized independently by physicists in the United States[5], the Soviet Union[6], and possibly in England.

The synchrotron which has been placed in operation at Iowa State College is designed to accelerate electrons to any desired energy up to 70 Mev, at which point the electrons are caused to strike a target within the vacuum chamber and generate an emergent beam of X-radiation for photonuclear research. The magnet and vacuum chamber were purchased from the General Electric Company, in whose Research Laboratory a similar installation[7] was in operation, while the assembly of components, testing, and operation of the completed system were undertaken by members of the College staff in order to make possible the versatility which would be insured by intimate familiarity with the details of the installation.

The machine operates as a betatron during the initial portion of its cycle, to carry the electrons from their initial injection energy of 40-60 Kev up to about 2.0 Mev. At an energy of 2.0 Mev the electron-velocity is about 98 per cent of the speed of light and operation may then proceed conveniently as a constant-frequency synchrotron with electron orbits of substantially constant circumference or radius. The electrons are constrained to move in a circular path of about 30 cm radius by a magnetic field whose intensity must then attain close to 8000 gauss by the end of the acceleration cycle. The magnet is a laminated structure similar in size to that required for a 50 Mev betatron, weighs approximately 8 tons, and is energized by magnetizing currents of about 130 amperes. These currents circulate in a resonant circuit of which the magnet constitutes an inductive element and with which a 3000 KVA capacitor bank establishes a resonant condition at a frequency slightly under 60 cycles per second. The power losses amount to some 25 KW and are supplied by a single-phase alternator whose shaft-speed is automatically controlled by a magnetic drive to provide excitation at the resonant frequency of the circuit. Groups of electrons are thus brought up to final energy,

in a time a little less than 0.005 sec, in bursts which occur at a rate of 50-60 per second. Since during the acceleration process a given electron must therefore traverse on its circular orbit within the synchrotron a distance of about one thousand miles (or almost the distance from New York to Chicago), it is apparent that the focusing properties of the magnetic field will be of great importance and must be examined with considerable care.

Due to lack of readily available space on the Campus, the synchrotron was installed in a specially-constructed building on a plot of land located a little under one mile to the west. The building was constructed in the form of an *L* and situated on the edge of a small ridge, with the accelerator proper in one leg of the *L* and the control-room, laboratories, office space, and shop in the other leg. The X-ray beam is directed so that it may pass out of the building, without the interposition of special shielding, to strike an earthen embankment within a fenced-off area. In this way it is possible to achieve not only very good protection from radiation hazard for the personnel, who would naturally vacate the accelerator room during operation, but the level of radiation intensity in the remaining portion of the building is found to be sufficiently low that sensitive counting equipment is not disturbed by operation of the synchrotron.

The elimination of the need for massive shielding immediately surrounding the machine not only is a convenience and affords a certain economy, but is believed also to be advantageous from the standpoint of reducing the background of spurious secondary radiation which would interfere with the interpretation of some experiments. During the latter portion of each operating cycle, when the electrons are approaching their final energy, an appreciable amount of visible radiation is emitted by virtue of the centripetal acceleration experienced by the electrons as they proceed on their circular paths. This radiation, and other phenomena of possible interest, can be viewed remotely in the control-room area by means of suitably arranged mirrors. Location of the synchrotron laboratory a short distance from the Campus proper, while involving some inconveniences, provides certain advantages from the standpoint of uninterrupted work and versatility in the operations.

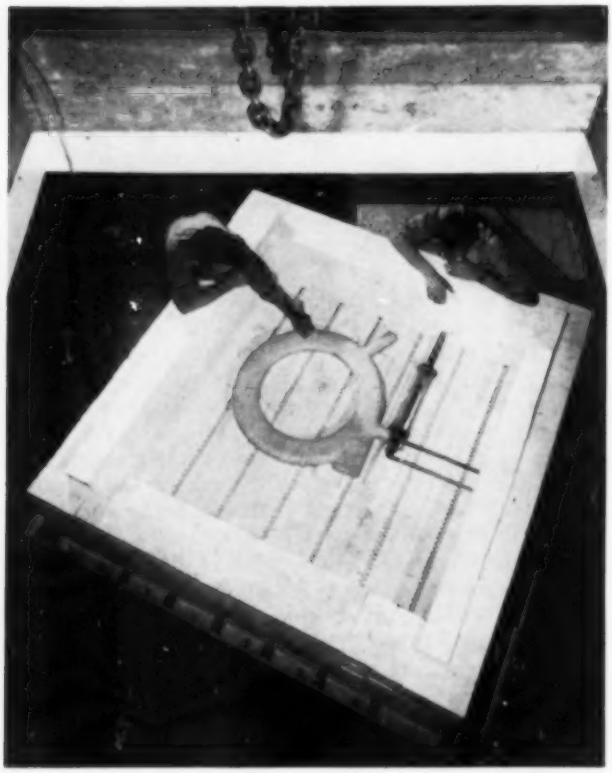

FIGURE 3. Donut Treatment Oven. Ceramic accelerating tubes are treated with stannic chloride vapors at 400°C to produce a conducting coating on their interior walls.

X-ray generators for photonuclear research at energies up to 70 Mev are relatively rare, although a number of laboratories are equipped with 22 Mev betatrons and there are several large installations operated at a few hundred Mev for investigation of the unstable meson particles. The availability at Iowa State College of this somewhat unique photon energy to some extent has served, therefore, to guide the direction of the research program.

The present understanding of photonuclear processes appears to be in a very incomplete state. In many cases the observed results seem best explained in terms of a "giant resonance," in which case absorption of an incident photon induces a collective oscillation of the nuclear matter as a whole, and then, in a somewhat distinct process, a nucleon (neutron or proton) is "boiled off" to carry with it a portion of the original excitation energy. In other cases, evidence seems to point to a more direct interaction between the photon and perhaps no more than a pair of nucleons, the reaction being then a sort of direct nuclear photoelectric process which leads to the emission of higher energy particles and to the forward direction being favored by the emergent particle. It may be expected that the relative importance of these rather distinct mechanisms would change as the photon energy is varied and that systematic studies over a range of energies would assist in clarification of the phenomena.

Investigations at other laboratories with X-rays extending up to 22 Mev energy have in many cases shown the emergent photo-protons to be of relatively low energy and to be distributed substantially isotropically, as would appear most reasonable on the basis of the concept of photo-excitation of the nucleus as a whole. With increased photon-energies it appears, however, that the photo-protons from such reactions come more and more to assume the energy distribution and directivity characteristic of a direct photoprocess. Such studies, which can be carried out by examining separately the properties of photo-protons divided into distinct energy groups, have been undertaken with the Iowa State College synchrotron and it may be hoped can be continued to provide a more complete picture of these interesting processes. Similar studies, with somewhat more difficulty, also can be performed with

the photo-neutrons produced in many reactions and appear to lead to similar results.

It is of some interest also to note that in certain photonuclear reactions deuterons appear to be produced in rather high relative numbers, despite the comparatively low binding energy (2.23 Mev) of the neutron-proton pair which forms the deuteron. By means of a 12-inch C. T. R. Wilson cloud-chamber, traversed by a magnetic field, the large yield of photo-deuterons has been confirmed in this Laboratory for the interaction of X-rays with copper and, recently, with sulfur. This deuteron production appears quite difficult to understand at the present time and it is hoped that further systematic experimental work will provide additional information to aid in suggesting a suitable theoretical interpretation of the phenomenon.

Another basic type of experiment in the photonuclear field concerns the determination of the *cross-section* or *reaction probability* for a specific photonuclear process as a function of photon energy. Since the X-radiation from the accelerator is inherently not monochromatic, but consists of a continuous spectrum of energies extending up to a maximum equal to the kinetic energy of the initial electrons, direct observations of the *yield* must be taken at a great number of well-controlled energies and then carefully analyzed to give the more fundamental cross-section. In reactions involving some of the lighter elements there is evidence that the yield curves show significant breaks, or discontinuities in slope, indicating the existence of a somewhat distinct structure in the nuclear energy levels which can be reached by photo-excitation. Modifications have recently been made to the synchrotron installation to permit more definitive monitoring of the electron energy in the interests of improving the reliability of observations concerning this level structure. These modifications are intended to bring the electron beam suddenly onto the target, so that an exceptionally short burst of X-rays is obtained from electrons of very definite and measurable energy. These same techniques will be of value in connection with a planned development intended to provide an *external* electron beam for fundamental studies of nuclear properties through the nuclear scattering of the electrons themselves. It is of interest to note that these technical modifications have been guided by the same recent developments in the theory of synchrotron design on which are based the plans for multi-Bev accelerators at a few central research laboratories.

Many experiments peripheral to the study of photonuclear processes are also aided by use of the synchrotron. Radioactive materials of many kinds can be produced with the X-ray beam. The amounts of radioactive substances produced in this way are not large in comparison with those made available by neutron irradiation in nuclear reactors, but the products are in many cases different. For the study of some radioactivities most conveniently produced by X-ray processes, a magnetic spectrometer has proven suitable, and in other cases methods employing scintillation spectrometers or proportional counters have proven satisfactory. Many of the radioactive products of interest possess very short half-lives—of the order of one second, or less—and in such cases the data are most conveniently recorded photographically and are subsequently subjected to automatic analysis. When investigating the properties of longer-lived radioactive materials, activities of possibly low specific intensity can be produced in relatively long samples exposed to the X-ray beam and subsequently "winnowed out" by chemical concentration to provide sources of considerably higher specific activity. In a number of instances the associated chemical problems become of considerable interest in themselves, involving the initial rupture of chemical bonds by the nuclear recoil in a manner akin to that first recognized in connection with the Szilard-Chalmers process[8].

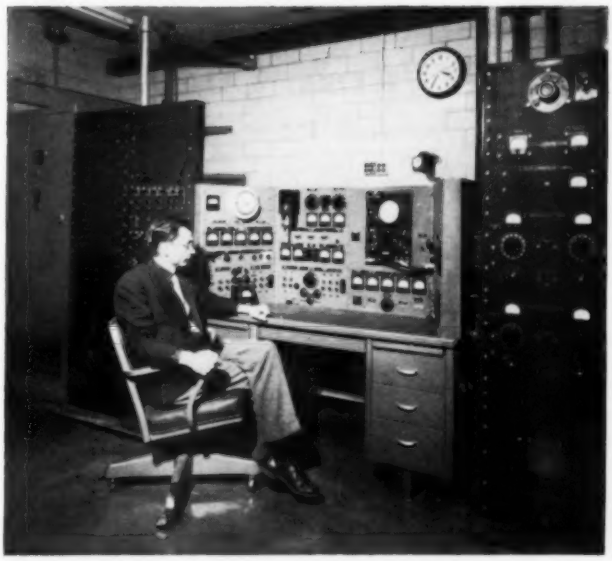

FIGURE 4. Control Room for Synchrotron. High radiation level in synchroton experimental room requires that all apparatus be remotely controlled by electrical circuitry.

The authors would like to close this article with the remark that the study of photonuclear reactions appears to be a field in which there is much to be learned experimentally before an adequate basic understanding of this interesting aspect of nuclear physics can be attained. We have found rewarding the stimulation of working in this field with graduate students and research associates from both this country and abroad and hope that continued efforts will contribute to an increased understanding and appreciation of the physical universe. It should be mentioned, however, that electron accelerators have useful applications in fields other than nuclear physics, such as for the solution of special radiographic problems and for medical research. Readers also may be interested in further technical details presented in summary articles listed among the references below[9, 10]. ●

CONTRIBUTION No. 394

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(Continued on Page 118)

Concepts and Techniques in Teaching The Organic Chemistry Laboratories

• By **Arthur Furst, Ph.D.,** *(Stanford University)*
ASSOCIATE PROFESSOR OF MEDICINAL CHEMISTRY, STANFORD UNIVERSITY SCHOOL OF MEDICINE, SAN FRANCISCO, CALIFORNIA

This paper considers the function of the organic chemistry laboratory, and offers a plan to make it more effective in training students to become all around good chemists.

Many of Dr. Furst's suggestions will be found useful in high school laboratory teaching.

Dr. Furst presented this paper before The Southwest Association of Chemistry Teachers, Northern Section, November 6, 1954 at Davis, California: at the Symposium "The Teaching of Organic Chemistry."

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There are two philosophies prevalent in teaching organic laboratory courses. Judging from the texts listed in the September 1954 issue of *The Journal of Chemical Education*, the majority of instructors feel that the main if not the only function of a laboratory is to illustrate by example what is presented in the lectures. This view, at least, is held by textbook writers at a ratio of 4 to 1. The main concern of this group is the correlation of lecture and laboratory materials. Timing is of the essence, for although it takes a few moments for the instructor to mention that ethyl alcohol can be obtained by fermentation, a number of laboratory periods are required by the students to prove it. Laboratory procedures invariably take extra time. Even drying an organic preparation takes overnight. To save laboratory time or to be sure that the class does a particular experiment at a given time, the instructor may find these three points helpful. (1) Semi-micro techniques may be employed profitably. An important point can be just as well illustrated by distilling a small amount of a compound in a few moments, as it can by using the usual laboratory amounts. (2) Test tube experiments can be used more frequently. Many reactions can be illustrated simply. Text books on qualitative organic analysis contain many good experiments that an instructor can easily adapt for a beginning course. Students can see what takes place, and certainly they can smell the product. (3) It may be expedient at various times to have the entire class do a particular experiment simultaneously. Thus on any laboratory day all students may be asked to do an experiment on a current problem and to postpone continuing the previous one.

A second, but much smaller group of organic laboratory instructors, feels that the organic laboratory must have for its major objective an introduction to the physical chemical concepts underlying the theory of separation and purification. One word of caution, however, on such a program: it is very easy to lose sight of the main purpose of the course and convert it into a physical chemical course, albeit a miniature one. Although it is important that the students get a good qualitative picture of constant boiling mixtures, melting point curves, etc., they must not be "snowed under" by the mathematics involved.

Perhaps the well rounded course should have several major objectives rather than one. It therefore need not follow closely any set of lecture notes, but will contain experiments to illustrate only a selected number of reactions and laboratory procedures. Part of the laboratory time can be devoted to a discussion to help the student to understand the reasons and theory behind the laboratory work. The instructor would do well to consider the following points:

(A) *Equipment:* Students need to be taught how to set up a good safe experiment. Invariably, the student who is alert soon learns that a set-up which is esthetically good is also mechanically good. Each piece of glassware must be independently clamped. No condensers should be allowed to dangle from the distilling flask side-stems. Students must be cautioned constantly against trying to force glass tubing into rubber stoppers. As the greatest danger in laboratory work is fire, it is of paramount importance that fire hazards be discussed early and thoroughly. Points to be made should include the following: (1) Glassware must not be heated by a direct flame unless specifically called for in the directions. (2) No liquids should be poured in the vicinity of a lighted burner. (3) Receivers must be protected and not be near a flame. (4) The distillate should not drop through the air. (5) On any one laboratory bench, students should set up adjacent equipment to have flame to flame and receiver to receiver. (6) Each set-up should be checked by the instructor personally before permitting the student to light the burner. This, naturally, takes a lot of time, but time spent in the beginning is saved in the long run, and real troubles can be avoided, i.e., any closed system can be spotted before use. Occasionally it is necessary to call attention of all the students to a poor set-up, not to reprimand anyone, but to discuss how to improve laboratory work. In cases of very poorly constructed apparatus, it is sometimes necessary to ask the student to tear the entire thing down and then rebuild it. The psychological effect on the class is interesting. It is also necessary to remind students that a fire hazard is involved after a distillation or fractionation is completed. For some unknown reason, students are prone to remove the thermometer from the hot fractionating column or distilling flask as soon as the run is over (and some immediately cool the thermometer under the tap!).

The student must also learn that in spite of our science being exact the means by which we measure that exactness is dependent upon the *art* of the science. The placement of a thermometer, the rate of heating melting point tubes,—all are important details. It is quite possible for different members of the class to obtain different physical constants by varying the techniques.

(B) *Introductory Physical Chemical Concepts:* What is the theory behind the laboratory operation? From the vapor-pressure temperature curve the various concepts can be illustrated, and the normal distillation and fractionating curves can be drawn. Statements can be made about the escaping tendency of pure solvents, which can be modified by the solutes, so that it is possible to have a maximum as well as a minimum boiling point. From the lower part of the vapor-pressure temperature curve the behavior of solids can be discussed. Minimum and maximum melting points of mixtures can also be included. Simple experiments can be conducted, such as distilling a mixture of liquids and then fractionating it. By plotting the volume of the distillate vs. temperature and constructing both curves on the same piece of graph paper, comparisons can be made. Cooperative experiments can also be worked out. Each student can be asked to take the melting point of two pure substances, and then the melting range of an assigned mixture of those two compounds. These values can be recorded on a convenient spot on the blackboard or bulletin board. When the entire range of concentrations has been covered, these data can be used to construct graphs. This serves as an excellent basis for the discussion of melting point curves. Sublimations can also be treated with reference to the same vapor pressure-temperature curve.

(C) *Calculations:* There are possibly three different types of problems encountered in the laboratory of the organic chemistry course. For one, most calculations are dependent upon balanced equations. It is rather surprising that no laboratory manual has a good treatment of this subject. Granted no scheme is really better than any other, it is still helpful for the student to learn a method that he can apply to organic as well as inorganic chemistry. There is no doubt that the use of (O) or (H) is quite simple; it is not necessarily, however, more helpful to the student. The valence change method is really misleading. Hence, the method of half-reactions should be that of choice. Parenthetically, there is no reason to balance equations other than for calculation of yields. The second problem the student has to face is the treatment of given data. Usually the procedure involved requires three or more reactants, and much to the student's horror he is given specific amounts in grams, moles or milliliters for each of these reactants. Upon which chemical does he base the theoretical yield? If the idea of *limiting factors* is discussed early, the student will be saved a good deal of confusion. The third new type of calculation the student faces is the use of mole fractions or mole per cent. Actually, this is no more difficult than the concepts encountered earlier in the student's career in chemistry. A good number of illustrations may be quite helpful.

(D) *The experiments:* The actual experiments assigned should be chosen to illustrate some of the reactions given in the lectures. It is impossible to cover the entire field; it is essential to cover the main points. For example, a number of simple transformations should be included; and oxidation and a reduction experiment should be there; a simple azo or triphenylmethane dye should be synthesized. If the class is especially well prepared, experiments illustrating rates should also be included. An experiment involving the importance of the order of addition of the various reactants would be desirable. Some of the laboratory work should be designed to permit the students to become acquainted with the common techniques of organic chemistry. This would naturally include distillation, fractionation, steam distillation, perhaps sublimation, melting points and, for the more advanced student, a chance to use three-necked flasks and motor stirrer.

(E) *Grading:* Students quite often feel that basing the grade of a laboratory course only on their quizzes and final examination, and not partly on the laboratory work, is unfair. They also are rather reluctant, then, to do good laboratory work. Frankly, why should they? Laboratory work should represent a definite percentage of a student's grade. But the instructor may ask, "What shall be the basis of a laboratory grade? What is there tangible for grading in the laboratory?" It is not necessary to grade every experiment, just as it is not necessary to grade every problem set. Many preparations can be graded subjectively; it is soon apparent to the instructor that the products fall in groups. This can be the basis of a grade. The color of the preparation and/or its type of crystals usually is a good indication of its quality; the appearance of an azo dye is adequate to detect a good or poor experiment. The boiling range of certain liquids tells whether that experiment was conducted skillfully. The melting point of a solid is a good criterion of its purity. The tendency to grade upon yields is not a wise one. Students soon learn there are two ways to increase yields. In the first case they will increase the amount of starting materials used. Secondly, they may use the following technique,—first, they weigh the container; second, they add the contents to the bottle; then cork it,—the bigger the cork they can find, the better; then they weigh the whole thing again, and the difference in weight is called the yield. Special experiments can be assigned numerical grades and these can be equivalent to a quiz. In these cases the students do not need to know in advance on which experiments the numerical grades will be based.

It is quite possible to be a good theoretical chemist with all thumbs. It is quite impossible to be a good organic chemist without being able to go into a laboratory and carry out a real experiment with some knowledge beforehand of what is to be done, some thinking about how it is to be done, a great deal of awareness and adjusting of conditions while it is being done, and finally some understanding of what was achieved. ●

Science Teachers as Counselors

• By **John Stratton, M.Ed.,** *(Duquesne University)*
DIRECTOR OF TESTING, DUQUESNE UNIVERSITY

Without the scientist, science will cease to exist. Vocational advisors can do much to increase the flow of high school graduates into scientific fields.

Are the potentialities of our high school science teachers being used effectively in guiding students into scientific careers? Are guidance officers overlooking a valuable co-worker?

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It appears very strange that whenever anyone discusses the topic of guidance for our youth in high schools, very little mention is made of the Science Department of the school and the part that it might play in the overall guidance program. Science teachers are in a very good position to become a vital part in the guidance program of the schools, in that they are in a position to supplement what is sometimes very meager information in the Science areas in the Guidance department.

For the past few decades, conservation of our natural resources has become a vital issue with our nation. As people who deal daily within the realm of science, you must be constantly aware of the need, and the desire, to conserve all of our natural resources. In many instances we are finding that a program of conservation is not enough to provide for our future needs. We can estimate the demands that will be made in the years ahead and realize that in addition to conservation, we must plan for replacement of the original resource with a material as nearly like the original as is humanly possible to produce. Our vast wealth of scientific knowledge has long been directed along such lines. Thinking along such lines is highly commendable and it is noteworthy that the teachers of the various science courses in our schools are working hand-in-hand with their fellow scientists in the experimental laboratories and in our industries to achieve such necessary discoveries.

Science has been able to work with many materials and discover new uses for them . . . Science has been able to utilize in many new and unexpected ways many of our waste products. But, what answer has Science to offer for the waste of our most valuable resource, human intellect?

This question is primarily directed to the teachers of Science courses in our high schools, and to a lesser degree to those who teach on a college level. Our high school Science teachers are in a position to offer so much needed guidance to our potential scientists. Yet, all too many of them neglect this golden opportunity completely! Most of our school systems have recognized the many values to be derived from an organized guidance program and have expended a great deal of time, money, and energy to install such a program in their schools. The guidance program operates for the immediate benefit of the students. It also operates for the future benefit of the community and our nation as a whole.

In this highly technological and "atomic" age, there have been increased demands for scientists of all fields and for just about all classifications of engineers. What are the requirements for a Chemical Engineer, Electrical Engineer, Mechanical Engineer, Geological Engineer? In what way, if any, do the qualifications for these various classifications of Engineers vary? What courses of study must a student take to qualify in these areas? What courses, although not "required," would prove to be a definite aid to success in these areas? In the area of Sciences, dependent upon the child's future vocational choice, what areas would prove most beneficial . . . Chemistry, Physics, Biology? ? ? ? It is only reasonable to expect that the faculty members of the Science departments of our high schools would be in the best position to present good sound advice to our students who have indicated interest in these areas. It has been noted, however, that such is not always the case. The whole burden of "advising" has been shunted to the office of the school counselor or the Dean of Boys, or the Dean of Girls. While one of the requirements of a good counselor is that he or she be well acquainted with occupational requirements, it is beyond the realm of reason to expect such a person to know, and to have at his immediate disposal, all information about all possible lines of vocational endeavor. I believe that a "team approach" to occupational and vocational counseling should function whenever possible. The counselor should be able to refer students interested in a particular field to some other faculty member who could normally be expected to be in a position to offer sound, and current, information concerning the requirements and possibilities of a particular field of interest. Our teachers of Science courses in our high schools have a very definite place in the "team approach" in guidance services.

The Science teacher in the Secondary school probably has a greater opportunity than any other subject teacher to provide sound, functional education and vocational guidance. The various science classes provide many excellent opportunities to blend theory with practical first hand experiential information. There is no need for the Science teacher to be chained to any particular technique or methodology. Information contained in text books should provide an opening wedge for what has become to be, on the part of the students, greatly desired incidental and corroborating information, covering various areas of Science

(Continued on Page 112)

The Science of Modern Household Laundry Appliances

• By O. H. Doutlick
DIRECTOR, APPLIANCE TESTING LABORATORY, WHIRLPOOL CORPORATION, ST. JOSEPH, MICHIGAN

This is the way we wash our clothes in the modern home. The gestures are not the same as used with the childhood song "This is the way we wash our clothes, early Monday morning."

Few people realize how much research has been required to develop our modern home laundry appliances.

This article will be of special interest to those who have read "Revolution in the Home Laundry" in our June issue.

The home laundry industry was just awakening at the turn of the twentieth century. The rise of the industry in 55 years is accounted for by active applied research, aggressive competition and demand of the homemaker.

The appliance field is applying the knowledge of diversified professional talent: Mechanical, electrical and chemical engineers, physicists, laboratory test engineers, technicians, field service engineers, home economists and market analysts.

Washers

The science of washing and the removing of soils from fabrics and clothing is a fascinating study. Tests indicate that four major factors contribute to the basic results. These factors, when properly balanced, give an ideal degree of soil removal.

We find that soils are removed from cloth by relative fiber deformation during the washing process. The cloth is flexed and squeezed repeatedly to loosen the soiling substances and allow them to "work" to the surface.

The detergent (soap or synthetic detergent) with an effective 0.18 to 0.27% (by weight) concentration in water serves as the emulsifier and suspending agent for the loosened soils. The soap-detergent manufacturers have cooperated mutually with home laundry appliance manufacturers in research and in formulations. The results, during the last ten years, are outstanding for improved washability and rinsability in home laundry appliances.

Water is essential for the chemical activity of the detergent and to suspend the clothing being cleaned by washing. The water serves as a soil-clothing carrier during the washing process and as a soil remover during the extraction and rinsing operation. Water hardness problems in the home are greatly lessened by the use of synthetic detergents. All purpose soaps continue to give good performance in water hardness of less than 8 grains.

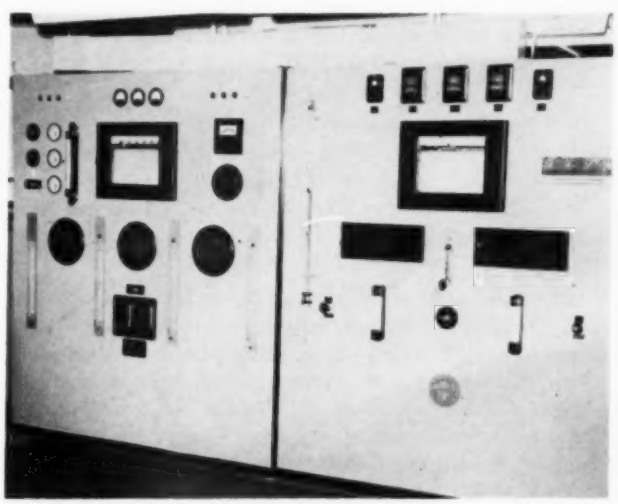
Rinsing is a prime requisite for bright white cloth and for fresh crisp prints and patterns. Rinsing is basically the dilution and removal of the detergent and soil residual of the washing cycles.

A well planned sequence of operations consists of:

1. Spin extractions, used for optimum removal of soils and detergent before intermixing the clothes with fresh water.
2. Spray curtain rinses, injected for cleaning the machine interior and clothing surfaces.
3. Deep agitated rinses, activated for loosening of embedded particles and for uniformity of rinsing.
4. Dispersed sprays, used in the final DAMP DRY cycle for preparing the machine for the following wash load, plus additional cleaning.

The present rinsing methods greatly lessen the homemakers problems of grey tones or yellowing.

Washing machines require a good balance of components, cycle of operation, and research. As an example, the size relationship of basket diameter and depth to the agitating means is a critical factor. A small diameter agitator in a large diameter tub does not give optimum action and cleaning. The ideal size relationships are achieved only through extensive research.



Instrumentations Panels

To Test Dryers:
All types of gases
Temperatures in the dryer
Analysis of CO and CO_2 in combustion exhaust

Washing machine designs of today have progressed through the years. Agitator design washers have been with us since 1880, and cylinder action methods since 1883. Pulsator action is an evolution of the vacuum cup principle of washing.

The agitator design machine, and the others mentioned above, have withstood the tests of time measured by customer acceptance. The design and development of modern agitators in relation to the basket or tub have been particularly important in the success of washing machines in the consumer market.

The original washers had a "tug-and-pull" action in the water. The present day agitator designs offer the advantages of a rhythmic movement in the water providing clothes rollover and circulatory action. The clothing movement and flexing gives a high degree of soil removal and uniformity (eveness of cleaning), with minimum wear.

Manufacturers of automatic washers use two types of water mixing valves:

(a) Solenoid operated valves with a thermostat unit for HOT, MEDIUM and WARM water selections. WARM is achieved by thermostat blending of hot water with cold to have tempered 90 to 105° F. water for delicate fabrics and for rinsing operations. The HOT selection allows water to flow directly from the water heater. The MEDIUM selection energizes the hot water and the cold water solenoids, giving an approximate 50-50 blend of hot and warm water.

(b) Solenoid operated valves allow for HOT, WARM and COLD water selections. The selections of water are achieved by energizing the respective solenoids of the water valves.

Methods of water extraction during the washing cycles are also of interest. The most efficient extraction is by the centrifuge method which consists of spinning the basket or tub at various speeds to extract by centrifugal force the water in the clothing. The spin speeds vary from 300 to 1140 RPM and the baskets vary from 16 to 23 inches in diameter.

The peripheral speed of the basket is the deciding factor in quantity of water removed during extraction. Increasing the speed of a basket or increasing the basket diameter at a given speed will improve the water extraction ability but excessive speeds have distinct disadvantages.

Balancing automatic washers during spin cycles with water and clothing is a problem for all manufacturers. Balance characteristics of washing machines are good with average wash loads of wearing apparel and household articles. The problems are related to heavy cotton throw rugs, bedspreads, etc., that cannot be balanced evenly in the basket tub during spin cycles as a result of the localized mass weight. The trade term for this load condition is "eccentric · loads" or "off-balance loads."

The designs used today incorporate springs, snubbers, balance rings, rubber ball cushions on + suspensions. The studies involve inertia, harmonics and dynamic balance.

Each manufacturer does attempt to isolate the vibration and sounds of the floating mechanism from the outer cabinet. The vibrations that are not isolated are transmitted directly to the floor after reaching the machine cabinet.

Conventional washers apply the pressure between two rubber rollers for water extraction. Wringer roll assemblies are available in two basic types:

1. Those which automatically adjust for the thickness of clothing by means of four coil springs.
2. Those with selective pressure positions for the homemaker to adjust manually. Typical settings are low, medium, and high for various fabrics and conditions. Adjusting is secured by means of a single leaf spring.

Dryers

Clothes dryers are a comparatively new appliance in the American home. The acceptance of the dryer as an all-weather, effort, work, and time saving appliance has been very rapid. Fabrics and clothing dried in a dryer are soft, fluffy and have a minimum of wrinkles. The problem of sun-fading of colors and prints are eliminated.

Drying principles applied are of three major catagories:

a. Condenser type dryers.

b. Convection heated dryers that exhaust the air.

c. Radiant heated dryers that exhaust the air.

Condenser types use the radiant heat method to evaporate the moisture from the clothing. Moisture evaporated from the clothing is chilled by the use of cold water. The quantities of cold water used vary from 1 to 2 quarts per minute of dryer operation. The transition from air borne moisture vapor to a liquid water condensate removes moisture from the clothing and the dryer drum. A small pump is used to remove the lint, condensed water and the condenser water from the dryer to the waste drain. Dryer designs use a cold water wall or a spray mist as the condenser medium.

Convection heated dryers are popular and efficient. Primary air is drawn into the dryer and passed over the heating elements. The heated air enters the dryer drum and raises the temperature of the clothing and of the moisture in the clothing. The moisture and lint are exhausted by the action of fans, through a lint screen or nylon mesh sleeve. The lint is filtered and entrapped by the screening.

Radiant heated dryers apply direct radiation from heating elements which are exposed to the clothing. The heat energy raises the temperature of the clothing and the moisture in the clothing. The exhaust air and moisture removal principle is similar to convection type dryers. Several manufacturers use a combination of

(Continued on Page 116)

The Early History of Chemical Laboratory Instruction

• **By Paul Walden**
GAMMERTINGEN-TÜBINGEN, GERMANY (Translated by Ralph E. Oesper, Cincinnati, Ohio)

No one can afford to miss reading this article. Teachers of biology and physics, as well as chemistry will profit greatly from Dr. Walden's history of chemical laboratory instruction.

If the lack of laboratory facilities is your excuse for not doing better work, the courage of some of the early chemists in overcoming almost impossible situations should spur you on.

This is Dr. Walden's second article. For a brief account of his life see page 7 of the March 1955 number of THE SCIENCE COUNSELOR. *Dr. Walden was 92 years old on July 14.*

I.

The development of material culture is intimately connected with the progressive discovery of new insights into the composition of natural products with the purpose of making them more suitable to the satisfaction and further shaping of human needs. Such glimpses into the inner nature of materials and the alteration of their composition—construed as chemical processes — assume practice, experience, manipulative skills, and technical aptitude. Goethe wrote: "All living, all performance, all art must be preceded by manual training, which is obtained only by imitation." And so it was that chemistry also began as a craft, as the art and practice of consciously executed and carefully planned attacks on the material nature of materials, as the important task of artifically modifying and recreating the material world, alongside of or out of the naturally occurring substances.

The chemical discoverer or inventor of the ancient world was a self-made man; he was an individual producer and the sole usufructuary of his new knowledge. This gave him a position of superiority in his group; it surrounded him and his art with an aura of secrecy. This monopoly was handed down from father to son (or a close relative) after the intended successor had been schooled in the profession under the senior practitioner.

This initial "monopoly" enjoyed by individuals was in time transformed into a state or temple monopoly with an accompanying increase in output. Such monopolies were cultivated not only by state officials but also by temple priests, who instituted supervisory measures, control of the workshops and ateliers, and subjected the products to critical examination. There were temple laboratories in the Pharaonic times, with apprentices and training courses, and in India. In the Buddhistic era, trained state functionaries, in special workshops, checked and tested the coins and products made of precious metals and alloys, and supervised the preparation of the "liquor" made from rice wine by means of the ferment "kinva."

This craft training was transmitted during the Middle Ages to the chemical practice of the Occident. There was a great expansion of culture and a marked un-

A CONTEMPORARY drawing of the famous Liebig "Laboratorium." Note that the chemists wear opera hats, silk scarves, elegant trousers.
This photo was made from an original in the Fisher Collection of Alchemical and Historical Pictures in Pittsburgh.

folding of practical chemistry during the life of Charlemagne (742-814). From the 8th century on there was a parallelism between the founding of states, the laying out of cities, the erection of large religious edifices, and the revival of the mining industries in the Eastern Alps, Carinthia, Bohemia, Hungary, etc. There was a constantly growing demand for craftsmen, mechanics, and chemical technicians of all kinds. Charlemagne set up manufactories for mosaics, metal goods, and art objects, and the monasteries also maintained active art academies. The chemical-technical interests of these monastic schools and laboratories are demonstrated by the collections of recipes and procedures which have come down from as early as the 8th century. These manuscript manuals deal with dyeing, preparation of pigments, metal working, glass manufacture and blowing, etc. They embrace the entire gamut of the chemical practice of the period. Particularly well known are "Compositiones ad tingenda musiva" and "Mappaae clavicula de efficiendo auro," and also the "Schedula diversarum artium" of the monk Theophilus Presbyter. Arnoldus Saxo, a minor cleric in Saxony, wrote an important chemical encyclopedia about 1225/30. As late as the beginning of the 16th century, Per Månson, who later became a Swedish bishop, collected chemical and metallurgical recipes in Italian monastery libraries, and the "Secreti del Rev. Domino Alessio Piemontese," a medico-chemical recipe manual, was published at Venice as late as 1535.

During the Middle Ages chemical operations were taught in the workshops and laboratories of the monasteries and the alchemists, in some of the mining establishments and smelters. The masters, then as now, frequently complained about their assistants and apprentices. For instance, in 1417, the English alchemist Thomas Norton wrote of his assistants:

"Some be foolish, and some overbold
Some keep no council of doctrine to them told
Some be filthy of hands and of sleeves
Some meddle strange matter, that greatly grieves;
Some be drunken, and some use much to jape,
Beware of these if you will hurt escape,
The true be foolish, the witty false
For when I had my work well wrought
Such stole it away and left me nought
Then I remembering the cost, the time, and the pain,
Which I should have to begin again,
With heavy heart farewell adieu said I
I will no more of alchimy."

II. Paracelsus to Liebig

A fundamental change in the essence of the earlier chemistry was brought about by Paracelsus (1493-1541) with respect to content, form, objectives, and public presentation. The thousand-year-old craft was brought by him into the academic disciplines, alongside of medicine and pharmacy. It was made a proper activity of physicians and apothecaries, worthy of their study and research efforts. The objective of this *iatrochemistry* was to prepare medicinals and to aid the human body and soul directly. Chemical activity was turned toward the making of chemical discoveries and the preparation of materials, and hence the question of training chemists became real. Paracelsus had learned chemistry from the practical side by serving as an apprentice in the smelting works and mining laboratories of Count Fueger in Schwatz, Tyrol "together with a number of his salaried fellow workers" and (like Goethe) could state: "What I did not learn there, I learned on my travels."

The subsequent development of chemistry and the training of its practitioners necessarily encountered the problem of suitable places of instruction. An important part was played by Andreas Libau (Libavius) (d. 1616 or 1620), who was a physician, humanist, Paracelsist, and "poet laureate," of Jena. He was well versed in chemistry and wrote the first textbook along the new lines. This "Alchymia collecta" (1595) was divided into two parts. The first "Encheira" dealt with the operations, the second part "Chymia" was devoted to a description of the materials themselves. The supplement contained a plan of an extensive teaching and research laboratory; the plan shows colonnades, gardens, baths, and a wine cellar; obviously the author was well aware of the need for recreational facilities. Libavius advanced the art of analysis by introducing the blowpipe, by working out methods for examining mineral waters, and especially by his "Ars probandi mineralia libri II" (1597).

A turning point in academic practices came in 1609 when the University of Marburg appointed Johann Hartmann (d. 1631) to the first professorship of chemistry. (He had been professor of mathematics and medicine.) In this chair of "chymiatry" he gave the first course in organized practical laboratory exercises; they were designed for medical students. According to the *Gelehrter Lexikon* of some 150 years later "a like post had not previously been known at any European university." Similar exercises were given at Jena by the professor of medicine Zacharias Brendel (d. 1626) and then by his successor and son of the same name (d. 1638). Their successor, in 1639, was Werner Rolfinck (d. 1673), who was even provided with a laboratory of his own and as "Director exercitii" gave demonstrations and metallurgical exercises. A well furnished laboratory was set up at the University of Altdorf in 1683; it was headed by the physician Johann Moritz Hoffmann, who in 1716 published his "Acta laboratorii Chemici Altdorfini," which contained 200 chemical exercises drawn from the three natural kingdoms.

The general conditions were doubtless responsible for the failure of these auspicious beginnings to grow and flourish in other places. For example there was no professor for "a collegium chymicum experimentale" in 1676/77 at the University of Wittenberg. The experienced practitioner Johann Friedrich Kunckel (von Löwenstern, 1630-1702) autodidact, inventor of ruby glass and co-discoverer of phosphorus, was given permission to conduct a course "in which there could be a little experimenting and analyzing." He soon was disillusioned and found that "there is little nourishment in living on students." Some of the latter believed that this course like others they were taking would consist of nothing but copying and words, "no, observation and setting to work are part of it."

A change came in the 18th century. It occurred in Saxony with Freiberg as the center. Johann Friedrich Henkel (1679-1744) who had been trained at Leipzig in medicine and who had quickly built up a reputation in mineralogy, metallurgy, and chemistry, was called by the Saxon authorities to undertake special assignments in field geology. From 1720 he had lived in Freiberg and in 1730 began to carry out his researches in the laboratory in his home and also used these facilities to give private chemical instruction. In time the latter became his main occupation and when, with state support, he built and equipped a new chemical laboratory in 1736 it quickly attracted students from Norway, Sweden, Russia, Switzerland, and other countries. Among these young men was Michael Lomonossov (1711-65) who set up a teaching laboratory at the Academy of Sciences in St. Petersburg in 1749. Among the German students was Andreas Sigmund Marggraf (1709-82) who later became a member of the Academy of Sciences at Berlin. Henkel's course included for the first time "analysis by the wet method." He stressed the use of all five senses and required his students to keep an accurate daily laboratory record.

After Henkel's death there was a short interruption in this school of chemistry. It was reactivated in 1747 by Christlieb Ehregott Gellert (1713-95) who had been trained in natural science at Leipzig and called to St. Petersburg in 1736 as instructor at the Academy of Sciences. He returned to Freiberg and set up his own chemical laboratory where his course in metallurgical chemistry soon won an international reputation. His fame was enhanced by his textbooks: "Anfangsgründe der Probierkunst" and "Anfangsgründe zur metallurgischen Chemie." When the mining school at Freiberg was opened in 1766, Gellert was its first professor of Metallurgy, Chemistry and Assaying; he held this chair until his death. In his later years he turned over the instruction in chemistry especially to his assistant Carl Friedrich Wenzel (1740-93) who made a place in the history of chemistry as one of the discoverers of the law of mass action through his "Lehre von der chemischen Verwandtschaft," published at Dresden in 1777. The 22-year old Wilhelm August Lampadius (1772-1842) was appointed assistant to Gellert in 1793. He was a pharmacist who studied natural sciences at Göttingen until 1791. He accompanied Graf Sternberg to Russia on a scientific expedition and later worked in the Count's iron works. In 1793 he published two theoretical papers. He was promoted the next year to associate professor of metallurgy and after Gellert died was named his successor. Lampadius was an exceptionally active, many-sided, creative chemist. He published 290 papers and books including a "Handbuch der chemischen Analyse der Mineralkörper (1801) with "Supplements" (1818) and "Grundriss der Elektrochemie" (1817). His "Chemische Briefe für Frauenzimmer von Bildung und Häuslichkeit" was a popular treatment of chemical topics of interest to ladies of culture and domesticity. He discovered carbon disulfide, analyzed soils and mineral waters, and recommended fertilizing with lime and potash salts, phosphoric acid (bone meal and ground phosphorite) and potassium nitrate. He deepened the chemical curriculum and infused it with a greater intellectual content by embellishing his lectures with demonstration experiments. His 2-volume "Erläuternde Experimente über die Grundlagen der allegemeine Chemie" (1810) enjoyed deserved popularity. From 1796 he conducted a course in which the students were required to prepare and analyze materials. His "Erfahrungen über Runkelrübenzucker" appeared in 1800. He put the first coal gas lamp in operation on the Continent in 1811.

This same period witnessed another line of development of chemical laboratory instruction arising from chemical-pharmaceutical sources. It, too, occurred in the universities. The Gmelin brothers, Georg and Philip, offered a course in chemical laboratory training at three year intervals at the University of Tübingen from 1753 on. Johann Friedrich Gmelin similarly gave such instruction at the University of Göttingen beginning in 1783. His successor, Friedrich Stromeyer (1778-1835) continued the practical training in chemical analysis after 1805. His most eminent student was Robert Bunsen; Eilhard Mitscherlich was also inspired to enter chemistry as a career under Stromeyer's influence. In 1796 Johann Batholomaeus Trommsdorff (1770-1837) instituted a "chemical-pharmaceutical institute" at the University of Erfurt. Regular chemical analytical courses were started under the patronage of Goethe by Johann Wolfgang Döbereiner (1780-1849) at the University of Jena in 1816.

Other famous analytical chemists offered instruction in mineral analysis. An outstanding example was Martin Klaproth (1743-1817) in Berlin. One of his students was the Swedish professor Andreas Ekeberg (1767-1803), who in turn taught the young medical student J. J. Berzelius at Uppsala. After the latter (1779-1848) became world famous as chemist, analyst, theoretician, author, abstractor, and critic, he opened his laboratory in his house at Stockholm to a succession of promising young men. The first of these was the 23-year-old Christian Gottlob Gmelin, who came to learn the art of mineral analysis. He was followed by the Rose brothers (Gustav and Heinrich), then by Mitscherlich, by Wöhler, and finally by Gustav Magnus. In due time all of these became professors in German institutions of higher learning, where they brought into the teaching laboratories the methods and research ideals of Berzelius.

This in short was the situation in the first quarter of the 19th century in Germany when Justus Liebig began his teaching career at the University of Giessen.

III. Liebig's Chemical Teaching Laboratory

When Liebig, fresh from training in Paris, came to Giessen as an enthusiastic 21-year old, he found the chemical instruction at a low ebb. However, the incumbent, who was not sympathetic to the progressive ideas, drowned while bathing in the Lahn and Liebig had a comparatively free hand in shaping the curriculum to fit his plans. In July 1825, he and two associates petitioned for authority to organize a chemical-pharmaceutical institute. There were only two similar schools in all Germany, namely the one at Erfurt under Tromms-

dorff and the one started in 1821 at Jena by the pharmacist-physician Christian T. F. Gobel (1794-1851). By July 1827, only a few months after the petition was finally granted, Liebig was able to report: "My chemical laboratory has been patronized this year particularly by students from abroad even more than from at home; Frenchmen and Hollanders are among this number." It must be emphasized that the instructional ideal of 1825 was not original with Liebig and was designed to meet purely practical needs. Decades later, he painted an entirely different picture of the conditions as he remembered them from 1820. "Chemical laboratories, in which instruction was given in analysis did not exist anywhere at that time; what were given that name were in fact nothing but kitchens, filled with all sorts of furnaces and utensils for carrying out metallurgical or pharmaceutical processes. Nobody knew how to teach analysis."

Obviously this personal opinion of the older Liebig differs greatly from the truth as set forth in the historical recital in the preceding section. The original features in the Liebig method of instruction was not the "analytical exercises"; the main distinguishing feature was the training in chemical thinking, observation, and experimentation. As a member of the Philosophical Faculty, his chemical curriculum was not dictated by the requirements of the Medical Faculty as had always been the case in the 17th and 18th centuries. Likewise he had no need to pay particular attention to the special needs of the mining and smelting industries. He was free to shape his curriculum according to his own needs and interests and to modify it according to the prevailing conditions. He was neither an inorganic or physical chemist; his scientific interests lay rather in applied organic chemistry. He taught: "The task of organic chemistry is to investigate the chemical requirements of life and the completed development of all organisms." This arbitrary limitation of the field was relaxed to include agricultural chemistry, and the physiology and pathology of the plant and animal kingdoms. His chemical instruction was accordingly slanted in these directions. His teaching methods were not pedantic but were tailored to fit the individual training and talents of the registrants in his laboratory courses. These students by 1837 were more than half from foreign countries and in 1851/52 more than two thirds (i. e., 42) came from "abroad." "They learned only in proportion to what they brought with them, I assigned the problems and supervised the execution." . . . "There was no fixed set of directions; each morning I asked each of them to give me a report of what he had done the day before and also his ideas of what he planned to do next; I agreed or stated my objections; each was required to find his own way by himself."

The conditions in the Liebig Institut were obviously very favorable for the foreign students and the Giessen laboratory became a veritable Mecca for those anxious to secure a sound and sensible training. Liebig's instructional methods became a model copied in many places because graduates of his school occupied many or most of the chairs in Europe and even in the United States. He did not hesitate to use the instrumental aids he had seen and used in Paris and his friend Wöhler provided valuable innovations from the Berzelius laboratory. Outstanding were the popularization of the so-called Liebig (really Weigel-Götting) condenser and the simplification of the combustion method for determining carbon and hydrogen (Liebig potash bulb), which were real milestones in the history of organic chemistry.

The secret of the Liebig method lay in the absence of pedantic pedagogy and the avoidance of a fixed set of instructions. Nature often functions by awakening dormant powers to cope with a given set of circumstances. Liebig employed this pattern. Active himself, and exuding enthusiasm, he created an atmosphere overflowing with zealous belief in the value of what was being done. He carefully protected the individuality of the student, but gently encouraged and if necessary prodded him to think for himself, to act independently, to make discoveries on his own. He intuitively understood proper psychological procedures, and on this basis created a school for training research men rather than placid unambitious technicians.

IV. Closing Thoughts

In these days of richly equipped laboratories, it may well be said in paraphrase of a familiar saying: "To become a chemist was not difficult, but to be a chemist is harder." Becoming a chemist was a difficult task a century or so ago, in fact it was sometimes tantamount almost to self-destruction. In 1851, when the young Kekulé told Liebig that he had decided to change from architecture to chemistry, the latter told him bluntly: "If you expect to become a chemist, be prepared to ruin your health; whoever is not willing to make this sacrifice will never amount to much in chemistry these days." In addition to the long hours at the study table under inadequate light, the young chemist also faced the greater hazard of spending his days in the miserable rooms which went under the title of "laboratories." These makeshift quarters lacked ventilation, there was no supply of gas, and even running water was not available in some cases. When Kekulé came to Heidelberg in 1856, the young Privatdozent was not provided with any working space or equipment because Bunsen was not sympathetic to organic chemistry. Kekulé's student, Adolf Baeyer described the "research Institut" which Kekulé had devised. "It consisted of one room with a window and two working places. The 'stink chamber' was an adjoining kitchen whose chimney was frequently ineffective. Therefore my work with volatile cacodyl compounds was accompanied by considerable danger to life and health. One day Kekulé found me unconscious and unable to call for help; my face was all puffed up. Kekulé added to this description of these working quarters: "In this little kitchen I completed my study of mercury fulminate, while Baeyer carried on his investigations of cacodyl compounds. We did not bother about the fact that the walls were thickly coated with poisonous arsenious acid and that mercury fulminate is highly

(Continued on Page 110)

The Staff of Life

• **By William B. Bradley, Ph.D.**
SCIENTIFIC AND RESEARCH DIRECTOR, AMERICAN INSTITUTE OF BAKING

Baking is now the second largest food industry in the United States.

Here is an article that should interest the old timer who dreams of home baked bread, and the youngster to whom bread is something that comes from the store.

●

The introduction of cereal grains in the diet of primitive man was perhaps the greatest single step towards the development of modern cultures. Grains have become such important sources of food that one or another of them is viewed as the Staff of Life by each nationality or racial group. Rice is the Staff of Life for many Oriental nations while wheat is the Staff of Life of most people in the Western hemisphere.

Grains assumed a prominence which warranted their consideration as the Staff of Life for several reasons. First they could be stored for long periods of time and, therefore, could serve as a staple food which could assure man's existence in times of drought, scarcity of game, etc. Their cultivation yielded a maximum of food with a minimum of effort thus providing time for man to use his imagination for building and the development of the arts and sciences. Their cultivation yielded a maximum of food from a limited acreage thus enabling large populations to exist in small land areas. Many of the cereal grains were found to be highly adaptable and could be grown under numerous conditions of soil and climate. All of these characteristics of grain provided a low cost food capable of furnishing not only a substantial proportion of man's energy requirement but a substantial proportion of the other required nutrients as well.

No wonder, bread, which is the most commonly eaten of the cereal products in this country, has continued to be of sufficient importance in our diet that the baking industry has become the second largest food industry in the United States.

Modern bread production is based on the principles of bread making established in ancient Egypt. However, man's engineering skill and application of scientific knowledge have developed a modern baking industry which differs materially in appearance and efficiency from that of the ancient Egyptian. No longer is wheat ground by hand between stones, bolted through hand sieves to remove the coarse particles so that a semi-white flour may be obtained and then kneaded by hand into a dough. No longer is dough inocculated with a starter of organisms retained from previous doughs so that fermentation might take place; nor is it baked on the hearth of a crude oven.

Modern bread production, like that of the ancient really starts with the farmer and the quality of the bread of various countries depends upon the quality of the wheat used as seed and the soil and climatic conditions during growth.

In today's wheat production, less then three man hours of work are required to raise an acre of wheat. This quantity of wheat will provide two men with a year's supply of energy and the major part of the other nutrients. Wheat is then milled in modern roller mills to provide a maximum yield of high quality flour. Much of this flour is converted in modern food processing plants into bread for distribution in the immediate vicinity of the bakery.

Most bread is made by a sponge dough process of bread making. By this process about 60% of the flour and 60% of the water required for an individual batch are mixed with yeast, yeast food, malt (if required) and the enrichment factors to form a sponge. The yeast converts fermentable sugars in the flour to carbon dioxide and alcohol. During fermentation, acids are are also formed either by action of the yeast or by action by bacteria indigenous to the flour. Amylases which are normal components of flour convert wheat starch into sugars to provide a medium for this yeast action. Should the amylase content of the flour be too low for the production of best quality bread, amylases may be furnished to the sponge through the use of malt (malted barley) or malted wheat flour. Sponge fermentation takes place at a temperature in the neighborhood of 80°F. and requires four to six hours. The length of time of fermentation depends upon the quantity of yeast used, the temperature of fermentation and the quality of the flour. During fermentation, the sponge rises in the trough because of the accumulation of carbon dioxide trapped in the sponge. When the sponge is properly fermented it is returned to the mixer together with the remaining water and flour and the nonfat milk solids, sugar, salt and shortening and mixed into a dough. Mixing, not only assures uniform distribution of the various ingredients but serves to develop the maximum extensibility of the wheat protein (an elastic mixture of proteins known as gluten). The continued stretching and folding of the gluten produces a large number of cells having very thin, extensible walls. In these cells, carbon dioxide, formed during pannery fermentation is trapped so that a fine-grained, soft loaf of bread of good volume is produced. After the mixing is complete, the dough is divided mechanically into the pieces required for the production of the loaves. These pieces are then rolled into a spherical shape and are conveyed by trays through the overhead proofer. The trip through the proofer, which takes about ten minutes, permits the dough piece to relax and yield to the moulding process. At the moulder the dough pieces are first rolled into sheets and then are rolled up like a scroll to form the loaf. The formed pieces are

panned and go to the proof box where they remain for about one hour at 100°F. so that the yeast can produce sufficient carbon dioxide to cause the dough pieces to rise in the pan at which time they are ready for the oven.

The heat of the oven first stimulates yeast action so that gas formation is increased, then kills the yeast cells and other organisms that may be present and finally converts the outer part of the loaf into a golden crust and the inner part into the elastic crumb. During the baking process the size of the dough piece greatly increases due to the increased gas production and due to the expansion caused by the heating of the accumulated carbon dioxide.

During the baking, both the carbon dioxide and the alcohol are driven off into the oven. Flavors are produced by the browning of the crust. From the oven the bread is cooled, sliced, and wrapped in a flexible moisture-proof wrapper so that it may be distributed to the ultimate consumer.

Although bread is virtually free of microorganisms when it is removed from the oven, it is an extremely perishable product. Staling begins as soon as the bread is cooled and continues up to the point of consumption. Staling is caused by a number of factors, among which are changes in the starch that cause the crumb to lose its initial softness and become firm and harsh. When bread is fresh, the crust has a low moisture content, while the center of the crumb has a moisture content similar to that of the initial dough. During staling moisture moves from the center of the loaf to the outside and thus the center of the slice tends to dry out though there is no loss of total moisture from the loaf because of the wrapper. This migration of moisture not only causes the crumb to become dry but it causes the crust to become moist and soft so that it loses its initial desirable crisp characteristic.

During staling, changes in flavor occur, which may be the result of a destruction of the initial fresh flavor or a creation of a new flavor less desirable or a combination of both. Much of the staling phenomenon is a reversible reaction and fresh bread can be made from stale bread if the stale bread is reheated in such a manner as to avoid loss of moisture. Staling is accelerated as the temperature decreases. Therefore, storage of bread in the refrigerator is not recommended. However, freezing inhibits staling. Bread held at O°F. will retain all of its original fresh characteristics for several weeks.

The difference in characteristics between commercially baked bread and home made bread is not a matter of ingredients but a matter of processing methods. In the manufacture of bread in the home, the mixing of the dough is a hand process which requires a great deal of effort. The hand mixing of the dough does not develop the gluten to its optimum consistency with a result that the finished bread is not as well risen, the cells lack uniformity and the cell walls are heavier.

However, the baker does use some ingredients which are not employed by the housewife. Practically all commercial bread is made from a formula that requires the use of a yeast food. Yeast foods are a mixture of a calcium salt (generally calcium sulphate or dicalcium phosphate), an ammonium salt (generally ammonium sulphate or ammonium chloride) and an oxidizing agent (generally postassium bromate but sometimes potassium iodate). The effect of calcium salts on the colloidal system in dough is a desirable effect and evens out differences in water hardness which effects the glutten quality. The calcium salts in yeast foods also contribute to the nutritive value of the loaf because the calcium from these salts is used by the body just as effectively as the calcium from natural food sources. The ammonium salts provide a source of nitrogen for the synthesis of protein by yeast cells. The oxidizing agent acts upon the gluten so that a bread of larger volume and better cell structure may be obtained. During the manufacture of bread these oxidizing agents are decomposed to leave a minute residue of bromide or iodide.

A soft bread is demanded by the housewife who, using softness as a criterion of freshness, makes her bread purchase after she first squeezes the bread. For this reason the baker may use monoglycerides of fat forming fatty acids in conjunction with his shortening because use of monoglycerides produces a softer loaf.

Calcium propionate is frequently used to retard the growth of mold which may find access to the bread during the cooling process. Difficulty with mold growth in bread, particularly in the housewife's bread box, is more common during the hot humid weather than during the winter months. Calcium propionate is the calcium salt of propionic acid, the fatty acid having three carbon atoms. It is a normal constituent of many food products which are manufactured by a fermentation process. It accounts, in a large measure, for the flavor of Swiss cheese and for the ability of Swiss cheese to withstand the growth of mold so commonly found on other types of cheese. The propionic acid portion of this salt is metabolized by the body just as any other fatty acid and the calcium is available for bone formation.

Analyses of commercial bread indicate considerable variation in formulation from one baker to another but the following formula approximates that which would be required to make average bread:

Ingredient	*Parts by Wt.*
Enriched Flour	100
Water (approximately)	65
Sugar	6
Nonfat milk solids	4
Shortening (including monoglycerides)	3
Yeast	2.5
Salt	2
Yeast food	0.4
Calcium propionate	.2

There is growing evidence that enriched bread warrants its reputation as the Staff of Life and deserves a prominent place in the diet. Six slices of enriched bread, which approximates the average daily consumption of this product, furnishes the following percentages of the recommended daily allowances for the

(Continued on Page 106)

Religion and Science Again

• **By Brother I. Leo, F.S.C., Ph.D.,** *(Catholic University)*
ST. MARY'S COLLEGE, WINONA, MINNESOTA

Brother I. Leo's reappraisal of an old controversy supplies some answers to present day problems.

Many are looking to an acceleration of progress in social sciences to insure the proper use of advances in science. Do they place all their hope in social science because they believe that religion is opposed to progress in science?

●

Of articles on the conflict between religion and science, the one, "Man Against Darkness," by Dr. W. T. Stace[1], professor of philosophy at Princeton University, is particularly provocative. Dr. Stace[1] attributes the decline of religion to science, beginning with the time of Galileo and with the idea that the cosmos is "utterly purposeless." Dr. Lee I. Smith, chemistry professor at the University of Minnesota states:

> Our lords spiritual—the clergy—are somewhat in eclipse in the modern world of today. They had their day, but they were unable, as a class, to keep pace with a changing world. Whether they can ever regain their former high position in the affairs of men remains to be seen, but certainly their example should serve both as a warning and as a stimulus.[2]

Remarks, such as Dr. Smith's certainly are a stimulus!

Clergymen are as emphatic as scientists when they comment on modern trends. In a Commencement Address in 1948, Reverend Francis Shea said:

> Colleges and universities have become temples of science from which graduates leave without a soul . . . Present day higher education pursues the physical sciences with a madness that makes them the be-all and the end-all of learning . . . Science has given us the atomic bomb that can destroy a beautiful cathedral or a magnificent city in an instant that required centuries to build. Science has given us an acid that can wither in a moment a precious flower that took months to cultivate. Science has given us a gas that in a moment can terminate the mortal existence of a mind that required years of study and experience to develop. But are we a happier, a more intellectual, a more religious people because of these contributions of science?

Even laymen sense the seething agitation. General Omar Bradley is quoted as having said: "We have too many men of science, too few men of God. We have grasped the mystery of the atom and rejected the Sermon on the Mount."[3]

Causes of the Conflict

What are some causes for this conflict between religion and science?

One cause is the belligerency of representatives on both sides. When a scientist reads "It is my opinion that religion is easily winning the fight started by a few men of science to supplant it," he is naturally impelled to assert himself against Msgr. Matthew Smith of *The Register*. On the other hand, when a religious person reads "Science cannot stop while ethics catches up—and nobody should expect scientists to do all the thinking for the country,"[4] he too is challenged to knock the chip off the shoulder, of Dr. Stakman in this case. Repeatedly in life, people are unwitting participants in arguments which had not interested them until somebody made a belligerent statement. Not infrequently, man finds himself in an indefensible position because he was pushed to make an "either—or" statement. Such experience probably accounts for some of the conflict between religion and science today.

Some beliefs of Catholics might be a cause of conflict. In fact, Lehman and Witty, after finding that only three of 1,183 outstanding scientists were Catholics, concluded: "The conspicuous dearth of scientists among the Catholics suggests that the tenets of that church are not consonant with scientific endeavor."[5] Catholic dogmas that perplex some scientists are: the existence of God; the divinity of Christ; the Virgin Birth; the concept of the soul and free will; a life hereafter; and miracles. The fundamentalist must be prepared to defend not only these dogmas, but he must be sure that youth are convinced of them before they ever come in contact with atheistic scientists. That the Church's teaching—on miracles, for example—need not be a stumbling-block for scientists is seen in the case of Dr. Alexis Carrel. Doctor Carrel, Nobel prize-winner in medicine, describes in detail his own extreme skepticism and, finally, his assent to miracles as he critically witnessed the cure of tubercular Marie Farrand Bailly at Lourdes.[6]

Most Catholic adults accept the dogmas of the Church without hesitancy, They, with pride, adopt the viewpoint of Chesterton:

> I have grieved my well-wishers, and many of the wise and prudent, by my reckless course in becoming a Christian, an orthodox Christian, and finally a Catholic in the sense of a Roman Catholic. Now in most of the matters of which they chiefly disapprove I am not in the least ashamed of myself. As an apologist I am the reverse of apologetic. So far as a man may be proud of a religion rooted in humility, I am very proud of my religion; I am especially proud of those parts of it that are most commonly called superstitution. I am proud of being fettered by antiquated dogmas and enslaved by dead creeds, for I know very well that it is the heretical creeds that are dead, and that it is only the reasonable dogma that lives long enough to be called antiquated.[7]

Some scientists mistakenly censure Catholics for their presumed attitude toward evolution and the geologic time-table. Catholics are required merely to believe that the soul is a special act of creation; they may accept or reject the evolution of the body. If evidence

shows that the earth has existed for two billion years and humanoid species for one million, Catholics may accept such time-intervals. The misunderstanding of some men is due to their erroneous idea of the attitude of Catholics towards the Bible. The Vatican Biblical Commission states a liberal policy for Catholics:

> On these matters which form the proper object of the physical and natural sciences, God taught nothing to men by the intermediary of the sacred writers, since such instruction could not be of any use for their eternal salvation. (Taylor, p. 19)[8]

Catholics are condemned repeatedly for impeding the progress of science. Usually, the treatment of Galileo is cited. Catholics admit the Inquisition was wrong in its decision to imprison Galileo. The men who condemn Catholics for this mistake would not be so violently emotional if they realized that Galileo's researches were financed by Church authorities before and after his trial; that his imprisonment was at a palace where he continued his studies. The Galileo case is not typical of the Church! Scientists—presumably always broad-minded—should know that through the ages the Church has supported the study of science. It was she who founded such institutions as the Universities of Paris, Padua, Oxford. Today, through the Papal Academy of Science, the Church recognizes both Catholic and non-Catholic scientists and sponsors research.

In the social area, some scientists resent the idea of resignation to suffering and poverty and to the practice of mortification; to them, these practices are below the dignity of man. However, du Nouy[9]—a biologist, a mathematician and a non-Catholic—writes: "Human dignity is based on the liberty to choose between the satisfaction of the appetites and the flight toward spirituality," (p. 104) and, "By fighting against his instincts, man humanizes himself" (p. 1). Some scientists object to the Church's teaching on birth control. For them, birth control is the easiest solution for poverty and over-population. A more recent challenge is that of man's longevity. Today men are asking: Should there be an accepted limit to treatments for men who are decrepit, declining, mentally suffering? For Catholics, indeed for every human being, euthanasia is always wrong. However, no one is required to take extraordinary means to prolong his own or someone else's life.

In the area of ethics, scientists find that their own way of life is secluded, rugged, almost ascetic. They are sometimes disturbed by the comparative laxity and levity of Catholics who have much higher motives for the disciplined life. Some research men go without meals, without entertainment, without sleep, without association with their own families in order to maintain vigils with experiments. They do not see the need for sustaining grace, for special strengthening of will to resist temptation. They lead truly dedicated lives.

Thus far, I have indicated a few Catholic beliefs that perplex scientists. What are some of the attitudes and practices of scientists to which Catholics occasionally object?

Sometimes scientists are denounced for their pursuit of investigations without giving any consideration to their value for humanity. Thus, the less informed, and without good reason, condemn scientists for the manufacture and use of nuclear-energy bombs. It is our Government's executive branch that makes the vital decisions on the use of these bombs. Scientists realize they have no tactical value except in densely populated centers; hence, their use will destroy thousands of people not actively engaged in war. An immoral use indeed! but not imputable to scientists. Scientists are condemned too for their investigations on birth control, eugenics, euthanasia, for experimentation on humans. Dr. Hugh Taylor writes:[10]

> The concept of human dignity and human inviolability thrusts itself immediately into the problem (of animal and human experimentation), and science has little if anything to say concerning these. The Christian scientist recognizes this condition and insists that unless his freedom to experiment is animated, tempered and restrained by sanctions outside his science, which have their origins in metaphysics or religious creed, there is no limit to the horrors that might be perpetrated in the name of a purely materialistic science, entirely amoral and aspiritual. (Taylor, p. 34)

Religious people object to the exclusion of philosophy from scientific curricula. Students who are exposed to philosophy would come to realize with Etienne Gilson that

> The central intuition which governs the whole philosophical and theological undertaking of St. Thomas, is, that it is impossible to do justice to God without doing justice to nature, and that doing justice to nature is, at the same time, the surest way of doing justice to God. When St. Thomas says that, unless there be an order of really efficient causes, there can be no science, because there can be nothing left for the human mind to know, he certainly shows his desire to lay for science the most solid foundation possible . . . Unless we know things, we shall never be able to know God; unless we know God, we are liable to be mistaken about the true nature of things.[11]

Catholics believe, I suppose, that man can learn more about revelation from nature than he can learn about nature from revelation.

Scientists who express well-or ill-founded opinions on social problems, juridical cases, political issues, and educational policies invite criticism. Scientists are not equipped, as scientists, to establish standards of conduct, no matter how objective their studies are on such topics as sex and alcoholism. They are not educated to make *ipse dixit* statements on the Immaculate Conception and the Virginity of the Blessed Mother. Scientists should avoid remarks which shatter ideals, such as "No ape patterns its present-day conduct on what some ape did one hundred years ago; why should man, then, pattern his conduct on a Man who Lived two thousand years ago?"

Scientists who promote atheism, materialism, secularism, Communism are targets for bitter remarks and feelings. Not only are these doctrines inimical to religion but they are also a threat to the State. Our democracy cannot possibly continue if we do not retain the sanctions imposed by religious dogmas and standards of morals.

Importance of the Conflict

Is this antagonism between science and religion worthy of consideration? In my mind, it is one of today's major problems.

The present generation has seen renowned scientists like James Conant, Arthur Compton, Albert Einstein, Alexis Carrel, Lecomte du Nouy gradually leave their scientific endeavors in order to concentrate on scientific humanism. They are seeking something, a system, to integrate the activities of men and of nations towards happiness and peace. Sometimes, their efforts result in a distortion of the Christian concept of virtue. Nobel-prize winner in physiology, A. V. Hill, in discussing over-population of the world, asks:

> Do human rights extend to unlimited reproduction, with a consequent obligation falling on those more careful? Should we continue to do the good we see in front of us, in confidence that if our motives are humane, good and not evil will finally result? Or, taking that rather easy course, are we not showing a lack of the fundamental virtues of courage and integrity? Can science replace older motives of human conduct?

The mere asking of the questions is a warning to Christians! A warning to what, for what? It is a warning to indoctrinate our youth more intensely than ever before in the convictions that should characterize a Christian.

The youth of America are taught by people who assume that there is a negative relationship between the study of science and the practice of religion. Consider the following excerpts, all from books on adolescent psychology:

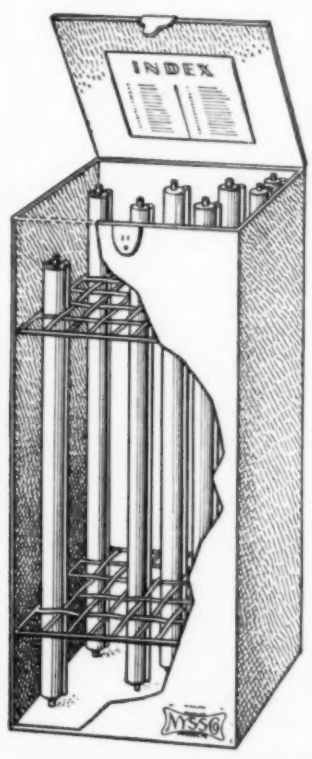
> He (the adolescent) has from infancy been brought up on an objective, unemotional presentation of scientific facts. He usually knows just enough science to block the acceptance of traditional religion but not enough to make a synthesis of science with religious and moral beliefs.[13]
>
> Pratt found that an interest in science generally, and certain sciences particularly, is negatively related to religious belief.[14]
>
> The destruction of early faith continues with the acquirement of certain scientific principles which are out of harmony with early learning.[15]
>
> There is nothing quite so spellbinding on people at present, and nothing to which they are more suggestible, than "science," especially when it is spelled with a capital S. Youth shares this obsequious reverence so that his confidence in religion is violently shaken when he hears repeatedly that "science" has disproved the worth and the need of faith."[16]

Should not the causes for this apparently incompatible relationship be learned? What can be done now to diminish the conflict between science and religion?

What to Do?

Men acquainted with the issues admit that some conflict will always exist. Maritain says that "Historically, religion seems to have done as much to divide men and

(Continued on Page 117)



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The Staff of Life

(Continued from Page 102)

twenty-five year old man as published by the Food and Nutrition Board in 1954.

Calories	12%
Protein	18%
Iron	20%
Thiamine	23%
Riboflavin	15%
Niacin	19%
Calcium	14%

Bread enrichment was started in 1941 in order to effect a greater distribution of thiamine, riboflavin, niacin and iron.[1] Surveys had indicated that these nutrients were most apt to be furnished in suboptimal amounts by many of the common dietary patterns used in this country.[2] Surveys[3] conducted since 1941 have demonstrated that enrichment of bread has effectively increased the intake of these nutrients and has been responsible, in a large measure, for the disappearance of pellegra and beriberi among our lower income groups.[4]

A recently published study[5] conducted in Germany following World War II demonstrates the value of bread as a food. This study made in orphanages revealed that diets which were predominantly bread, supported optimum growth and development in children whose ages ranged from five to fifteen years.

In the study five kinds of bread were employed—whole wheat bread, enriched bread, white bread and bread made from 85% extraction flour and bread made from flour enriched to less than the common levels. All breads were fortified with a calcium salt. However, the enriched bread used in this study contained less calcium than is found in average enriched bread in this country. The diet provided an average daily intake of eight grams of animal protein while the breads, made from a simple flour, water, yeast and salt formula, provided 75% of the average caloric intakes over the entire year of the study.

Development as measured by height and weight changes, bone density and repeated physical examinations was equally good irrespective of the type of bread used.

Balance studies indicated that all of the diets except that based on unenriched white bread furnished a substantial margin of safety in B-vitamins and that the protein of all diets was satisfactorily utilized in tissue formation.

Although no one in this country with its plentiful supply of a wide variety of food would want to advocate the use of diets such as were fed these war orphans, the study does confirm the concept that bread truly is the Staff of Life. ●

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"To have God as a constant point of reference in daily life is the one absolute way to meet and to solve the great problems we face at present in our society. Science alone cannot solve it for the problem is spiritual. Only man himself can meet and solve this problem for it is within his power to determine the uses of science. In his determination moral principles must come to the fore and be applied. With their application science becomes a handmaid to civilization rather than its assassin."

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Democratic Society

(Continued from Page 86)

pily, inconclusive—the prospects are not bright. Both the contemporary painter and the contemporary writer appear to have abandoned the reflective mood in favor of a hopeless effort to reproduce only the moment of sensation. The great questions of man and his destiny are ignored in favor of an obsession with the here-and-now. Artists and story-tellers are painting and writing in a jargon designed to appeal only to one another—witness James Joyce's *Finnegan's Wake*, Dorothy Richardson's *Pointed Roofs* and Virginia Woolf's *To the Lighthouse*. Having lost touch with the people they cannot inspire or lead or teach.

If the trend continues we face a supreme tragedy. For no matter how we view the material advances, no matter with what awe we contemplate the work of the scientists the fact remains that the use or abuse of these discoveries will depend in a democracy largely on the will and desire of the people. Whether the wielders of power are the managers of the giant corporations or high Government officials both must operate within a framework of individuals whose desires (good or bad) hold the ultimate influence. Since the choice reflects the individual's ultimate conception of what is the good life the choice becomes a matter of mind and spirit. The need of our day, therefore, is for teachers and theologians and philosophers—and above all else, for saints.

Within this context it becomes clear that a teacher in mathematics and sciences has a profound challenge to produce young people for these fields. Yet the challenge to the Catholic teacher of mathematics and science is two-fold: to produce technicians and to produce saints. Since mathematicians and scientists live and work with symbols it is urgent that they never lose sight of the symbol most desperately needed in our day—the symbol of the Cross.

Catholic educators must sear into their own souls and into the hearts of those entrusted to their tutelage this symbol of the Crucifixion. As humanity moves through its own Gethsemanes and as it stands in terror of immolation it is the Cross alone which in glorious mystery offers them solace and inspiration. To this dual dedication are you called — let not the challenge fall to others through forfeit! ●

★ ★ ★ ★ ★

Hygiene?

A friend of mine was being shown around a factory in France where they make those little pound loaves of bread. The owner was terribly proud of this factory. It had he explained two wings. In one wing the bread was made. At no point in the process had it been touched by human hands. In the other wing were manufactured the paper containers or bags the bread was to be put in. At no point had the bags been touched by human hands. Eventually the two wings of the factory met. There on a table or bench was the loaf on one side and the bag on the other. And so very quietly the man picked up the little loaf in his right hand, and the celophane bag which had come out flat from the machine in his left hand and said: "Now you see the end of the process; all you have to do is to insert the loaf into the bag . . ." And then he blew into the bag and inserted the bread.

The moral of that story, and its a very wise moral, is that it's more important to be human than hygienic.

Gerald Vann, O.P.

★ ★ ★ ★ ★

It is only the shock of an unpleasant experience that, ordinarily, drives men to energetic thinking. If life did not present problems men would readily lapse into a state of mental stagnation. Happily for the vitality of the human mind, life does present problems and ones that clamor for an immediate solution.

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Laboratory Instruction

(Continued from Page 100)

explosive." Another example was provided by the University of Bonn, which founded only in 1818 would presumably have a laboratory containing all current improvements. Actually, there was a chair of chemistry and a separate chemical laboratory. However, this was in the old Poppelsdorf palace and a total of four working places were provided. As late as 1857, one of the Privatdozents applied for retirement on the grounds that he had become ill "as the result of the bad condition of the laboratory atmosphere."

Liebig was well aware of these impossible and needless conditions and had been one of the most vehement critics of bad laboratories. Yet when he accepted a call to Munich in 1852 and was allowed to draw the plans for a new building, he made no provision for laboratory instruction on a proper scale. As the years passed he had become sick of supervising the practical work and stipulated that no obligation to give such courses would be part of his new post. Consequently, there arose the great paradox that the man, whom many regard as the father of modern chemical laboratory training, made no provision for such work in the Munich laboratory. For two decades, Munich had a "modern" building and a world-renowned chemical figure at its head, but it had no up-to-date chemical training and research facilities and produced no rising generations in chemistry. Liebig had deliberately sacrificed his former ideals on the altar of his personal need for relief from what had become drudgery for him.

Consequently, the problem of chemical laboratory instruction proved more complicated than merely providing suitable laboratories and adequate equipment. The human factor was an important one. The old saying: "It is not so much a matter of the cage as of the bird that sits in it" acquired a new meaning in this respect. One of Liebig's students A. W. Hofmann (1818-92) was called to London in 1845 to head the Royal College of Chemistry, which had been founded by Prince Albert, who was aware of the poor condition of chemical training in Britain and who was well acquainted with the Liebig school at Giessen. It was in this laboratory that young William Henry Perkin (1838-1907) discovered (1856) the beautiful dye "mauvein" an important early step in the founding of a new chemical industry. Kekulé announced his benzene theory in 1865, Graebe and Liebermann synthesized alizarin in 1868, and Baeyer began his investigations of indigo in 1866. Private capital was poured into the corporations organized to utilize coal tar and the demand for trained chemists and chemical research men grew ever more insistent.

The government stepped into the picture and funds were provided for the erection of buildings and the support of chemical research. In Germany, new laboratories were built at most of the universities, e. g., Kiel (1862), Halle (1863), Bonn (1864), Berlin (1867), Leipzig (1868), Munich (1876). Hofmann came back to his native country in 1864 and Kekulé returned from Belgium in 1865; they became the leaders in the wave of preparative organic chemistry which swept over Germany. This upward movement was furthered by the rejuvenation of chemistry at Leipzig by Kolbe in 1868 and by the arrival of Baeyer in Munich in 1875 as Liebig's successor. It was Hofmann, then, who pioneered in the sense of Goethe's declaration: "The sciences ought to affect the outside world only through increased technical application."

It was not only the great industrial applications but also because of the host of successes in meeting new problems that organic chemistry assumed a dominant position. The training, formerly restricted mostly to analytical and inorganic chemistry, was supplanted in large measure by a distinctly organic curriculum in which syntheses and preparations were emphasized. Another branch stressing primarily the physical aspects was initiated principally by Wilhelm Ostwald (1853-1932) who built up his great school of physical chemistry at Leipzig from 1887 on. Thus in the course of years, laboratory training in chemistry, which once had been practically non-existent, became one of the main foundations of chemical education. In the early days such courses were designed to develop dexterity in manipulation, to promote keenness in observation. Today such courses strive to teach shrewdness in putting questions to Nature and to arouse a critical sense in the interpretation of experimental findings. The goal is to produce not mere technicians but competent research personnel and chemical discoverers. The objective is that defined more than two centuries ago by Diderot: "La chimie est imitatrice et rivale de la nature; son but est aussi étendu que celui de la nature même." ●

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* *Translator's note.* The author has obviously based his text on the facts relating to his own country. However, the pioneering work was actually largely German in origin and the literature contains very little about the corresponding developments in other countries. It is hoped that competent authorities in England, France, Sweden, Holland and the United States, as well as other European countries will some day write the national histories of this branch of chemical education.

In his interesting pamphlet "William H. Keating and the beginning of chemical laboratory instruction in America" (The Library Chronicle, **19**, #1,(1952-53) Wyndam D. Miles has nicely summed up the subject: "The use of laboratories designed for the purpose of teaching was the third and final stage in the evolution of chemical education. The earliest instruction was done by lectures alone, without the benefit of the demonstrations or student participation so routine today. The second stage, in which the professor actually showed students the phenomena and materials of chemistry, was practiced occasionally in the latter part of the 17th century but became a standard technique of the teacher only toward the end of the 18th century. The last stage, in which the student learned chemistry by working in a laboratory, was not developed until around 1800 and did not become widespread until the middle of the century." It was in this last stage that the German pattern was so important.

RALPH E. OESPER.

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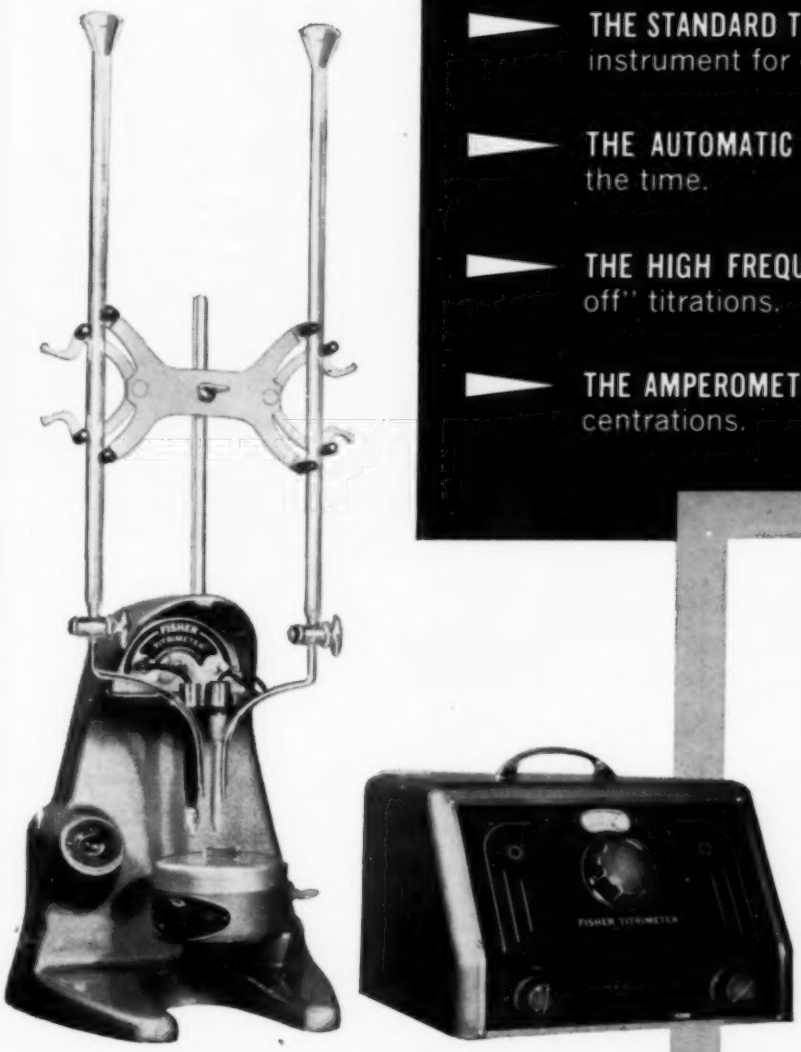

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Teachers as Counselors

(Continued from Page 94)

To really be of service to the students, and to be an active participant in the "guidance team," the Science teacher should obtain as much information as is readily available to him concerning the many facets of the pupils in his classes. A wide variety of information becomes available to him almost immediately. The school records, of course, will provide him with information concerning academic subject matter achievement. Additional background information on the students that compose his classes may be obtained from cumulative record folders and standardized test results. The test results are particularly valuable in that they provide an insight to the student's interests, abilities, and aptitude. With this more or less objective information available to him to either support or refute his own subjective information, the Science teacher has a wealth of information with which to begin assisting his students.

Another opportunity for the Science teachers to participate in the overall guidance program presents itself through the media of extra-curricula activities. Science clubs, for example, can devote time at meetings in which an opportunity to discuss all of the professions and occupations requiring a scientific background is provided. To initiate this program, individual members of the club might propose an occupation, or an area of occupations, that could be explored by the group as a whole. This type of investigation provides an opportunity for all of the members of the club to aid in the collection and collation of the desired information. For example, some students could be responsible for the compilation of a bibliography of books, articles, films, and film strips. Others could have the responsibility of establishing an "occupations" library. These pupils should collect information pertaining to the requirements and possibilities of a particular occupation including mental and physical requirements, initial salary, opportunities for advancement present and anticipated employment opportunities and other particularized information. If possible, the club might endeavor to arrange for a field trip to a site where the particular area of interest is being carried on. Most of the metropolitan districts provide many opportunities to observe Engineers, Physicists, Chemists, Doctors, Dentists, and various classifications of technicians performing their routine tasks. To supplement such field trips, or if such a trip is not possible, the club should endeavor to have a speaker who is actively engaged in that particular work at the present time come and address the club and/or serve as moderator for a group discussion of the area under investigation. The Science teacher and guidance personnel should also solicit the services of the school librarian, whereby the library would prepare a display of reading material related to the particular area of interest, or at least have such reading material readily accessible for interested students.

Another approach by which the Science teachers could enter into the guidance program would be to keep in close contact with the college from which they graduated so that they might be aware of any changes in course work in the science areas, or contemplated changes in requirements and courses, so that they might be in a position to impart this information to their students. Along with knowledge of the activities of their own alma mater, they should also be familiar with the programs and activities in other similar schools. This information would prove most valuable in helping the teacher to properly advise his students as to the proper procedure and preparation for work in the area of Science on the collegiate level.

All of the ideas and suggestions presented here offer an opportunity for the Science teacher to actively participate in the guidance of the students in his department with a minimum of effort on his part and place no demands upon him for "specialized" training in the area of guidance and personnel work. The carrying out of such suggestions should most certainly result in a more closely knit group of students who have a common educational interest, and should also better prepare these high school students to take their place in a field of science after high school even though many of them may not continue their formal education after their high school graduation. ●

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Child Health Correction

(Continued from Page 86)

treatment at the time of the examination. Percentages were still higher for dental defects: 68 per cent reported knowing their child needed dental treatment, and of them 42 per cent had the child already under treatment. It would seem desirable to avoid the public expense and trouble of re-examination of children already under treatment.

The question of ability to pay for medical and dental care often arises in these discussions. Indeed, income did seem to play a very real part in determining whether a child would or would not be taken to a physician or dentist. In families reporting incomes below $2,000, 47 per cent of the children with medical defects and 40 per cent with dental defects were taken for corrective action; families with incomes of $2,000 but under $4,000, 54 per cent and 52 per cent; $4,000 and over, 63 per cent and 73 per cent. Note two things: variation in income seemed to have greater effect upon dental corrections than medical corrections, and there was still a serious percentage of children untreated even in the higher income group. This could well indicate a continuing need for adult education or motivation about the health needs of children among all classes of society.

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This is pointed up by the fact that the last grade of school completed by the parents was important; of the children whose fathers had not finished the 8th grade, 48 per cent received medical corrective action and 45 per cent dental, while of the children whose fathers had completed college, the percentages were 81 per cent and 89 per cent. (But note that there was still room for improvement. Neither formal schooling nor money are cure-alls.)

Rural children were clearly at a disadvantage, although the research team noticed little rural shortage of medical or dental personnel. Families living in the open country took corrective action for 44 per cent of the children with medical defects and 37 per cent of those with dental defects. In villages and boroughs under 2500 population, the same figures were 52 and 60 per cent; and in places of 2500 and over, 65 and 66 per cent. Accompanying this was the discovery that nurses in rural schools, who carry the same pupil load as nurses in urban schools, were unable to contact their families as thoroughly. Parents of medically defective children in the open country and villages of less than 1,000 were contacted by the nurse in 25 per cent of the cases; in places of 1,000 but less than 10,000, in 33 per cent; and in places of 10,000 and over, in 50 per cent. Corresponding figures for dental cases were 7, 18, and 25 per cent. It would appear that special care should be taken with rural families, and special provisions be made for transportation facilities and reduction of pupil load for nurses who work in rural areas, if the value of school health examinations is to be realized in all residential classifications. This can be underscored again by the fact that rural families are larger than urban, and a visit from the nurse can affect the health of more children than a city visit can. In the open country and villages of less than 1,000, seventy per cent of our children came from families with 3 or more children under 18; in cities of 10,000 or more, only 50 per cent. ●

★ ★ ★ ★ ★

"The subsequent development of man's concepts of the universe—which has rightly overturned the ancient geocentric and anthropocentric ideas, has contracted our planet to the dimensions of microscopic star-dust, and has shrunk man to the size of an atom on this bit of dust, confining both in a corner of the universe—does not constitute an obstacle, as some have claimed, in discussing the mystery of the Incarnation, either for the love or the omnipotence of Him Who is pure spirit and as such possess an infinite superiority to matter, whatever be its cosmic dimensions in space, time, mass and energy.

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Modern Laundry Appliances

(Continued from Page 96)

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"What thing is then this spirit of infinitesimal man, physically lost on the ocean of the universe but daring to ask his extremely limited senses to discover the countenance and the history of the boundless universe, and then succeeding in revealing both of them?

"Only one answer, strikingly evident, can be given, and that is: The spirit of man belongs to an order of being essentially different from, and superior to, that of matter, even though that matter be of immeasurable mass."

—PIUS XII
The Progress of Astronomy

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Religion and Science Again

(Continued from Page 105)

sharpen their conflicts as to pacify them."[17] If religion, which to many connotes brotherly love, has had such an effect, we should expect nothing better from science. Since conflict is inevitable, the proponents on both sides should expect it and not get emotionally aroused as they discuss issues.

From the example of learned men, it is evident that a man can be a scientist and a Catholic. Some present-generation scientists who are Catholics are: Peter Debye at Cornell University, a Nobel-prize winner in chemistry; Hugh S. Taylor, Dean of the Graduate School at Princeton University, a member of the Papal Academy of Science; Karl Herzfeld, formerly physics professor at Johns Hopkins University and currently at the Catholic University; Norbert Scully, famed for radioactive researches in botany at the Argonne Laboratories; Lawrence Quill, head of the chemistry department at Michigan State; Raymond N. Bieter, head of pharmacology at the University of Minnesota; Dr. Julia Herrick, a professor in experimental medicine at the Mayo Clinic; Reverend J. A. Nieuwland, deceased, who received the Nichols Medal for his basic research on synthetic rubber; F. Sherwood Taylor, Curator of the Museum of the History of Science at Oxford; Dr. Edward Baldes, research director of the division of physics and biophysics at the Mayo Clinic. In the history of science, some Catholics are: St. Albertus Magnus, Roger Bacon, Francis Bacon, Pierre Curie, Becquerel, Galileo, Volta, Galvani, Torricelli, Kircher, Foucoult, Pasteur, Coulomb, Hauy, Mendel, Marconi, and Copernicus.

Catholics might take a greater interest in science. Ideologically, Catholics are more inclined to the arts and other humanities. Economically, Catholics generally need to earn a livelihood as soon as they obtain their bachelors' degrees; or, they are not willing to make the sacrifices involved in securing doctors' degrees, the beginning point for a life of research. Idealistically, the science professor in the Catholic college feels obligated to his students rather than to his research. Today, however, it is imperative that Catholic institutions improve the quality and volume of their research. That they are doing so might be inferred from the new science buildings at many of our schools, such as St. Thomas College, Manhattan College, and the University of Notre Dame. Since much of the research at State universities is now financed by federal funds, it is generally applied research. This situation provides a unique opportunity for Catholic institutions to assume leadership in fundamental and independent research.

Catholics could be more active in the scientific societies. Usually people with professional spirit aim to make a contribution to their field. For those who are not in a position to extend the "frontiers of knowledge" by research, significant contributions can be made by personal service to societies, libraries, laboratories, journals, and the education of youth.

Catholic leaders, the clergy in particular, should avoid making derogatory remarks about science. In fact, they could be more active in the correlation of religion and science.

Instead of concentration on differences, all should note the characteristics that are common to religion and science. Both are opposed to all prejudice—race, class, color, creed; both aim to reduce suffering and the hardships of poverty; both search for truth; both insist that truth makes man free. Catholics can be confident that truth—any truth—will fit into their religion. In 1855, Cardinal Newman, in his essay on "Christianity and Scientific Investigation" wrote:

> He who believes Revelation with that absolute faith which is the prerogative of a Catholic, is not the nervous creature who startles at every sudden sound, and is fluttered by every strange or frightful appearance which meets his eyes. He has no sort of apprehension, he laughs at the idea, that anything can be discovered by any other scientific method, which can contradict any one of the dogmas of his religion.

All should practice kindness, consideration and respect for the opinions of others. What Maritain writes on the fellowship of believers in his essay, WHO IS MY NEIGHBOR?, may be applied to the conflict between science and religion:

> I think it is clear that the basis of such a fellowship is in the Catholic outlook. This basis is not of the order of the intellect and of ideas, but of the heart and of love; it is friendship, natural friendship, but first and foremost mutual love in God and for God. ●

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No Miracle Cures

There is nothing in your medicine cabinet, in fact nothing in any drugstore that can cure cancer. The American Cancer Society, which has spent more than $35,000,000 on research in the last ten years, knows of no medicine, or pill, or ointment, or massage, or electric treatment that will cure a malignant growth. The only realistic hope for any cancer victim is early detection, correct diagnosis, and speedy treatment. Nothing except surgery and radiation has been found effective as a cure, and even with these it is the surgeon and not the knife, the radiologist and not the voltage, that gets the results. About a score of chemical compounds being used experimentally have proved helpful in alleviating pain, extending life, and sometimes reducing tumor growths to an extent that permits cure by surgery or radiation. The American Cancer Society has helped scientists sift through many thousands of drugs and chemicals to uncover these few promising leads. Eventually, continued research in chemotherapy may produce a cancer cure, but that time is not yet—despite misleading claims of the panaccea peddlers.

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ACS Medical and Scientific Director in CANCER NEWS

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Nuclear Research

(Continued from Page 91)

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★ ★ ★ ★ ★

In recent days I have repeatedly had the opportunity of referring to the decisive struggle which is going on between the constructive forces of the free world and the destructive powers of atheist totalitarianism. In this decisive struggle, the military defense, economic consolidation and social progress of the free nations play a great role, to be sure. But let there be no illusions about the fact that military and economic strength alone will not be able to offer resistance to the ever-spreading totalitarian ideology.

We are in the midst of a decisive spiritual struggle in which universities have a great task to perform. Some educational institutions bear an ample share of responsibility for the false ideologies menacing the peace and freedom of the world through totalitarian systems of different kinds. Many of these destructive theories were taught from academic chairs long before politicians got hold of them, popularized them and made them into totalitarian party ideologies. The reason I am so outspoken about this is because I am anxious to stress the responsibility which rests on institutions of higher education throughout the world, and particularly in both our countries. It is their responsibility to do everything by way of scientific research and teaching to disprove false theories endangering the future of the world, and to discover and develop the principles best suited to guarantee to human society, as organized in the family, the state and the comity of nations, that healthy and peaceful progress which humanity has a right to expect.

—DR. KONRAD ADENAUER
at Georgetown University

New Books

Life Science

• *By* THOMAS S. HALL and FLORENCE MOOG. New York: John Wiley & Sons, Inc. 1955. Pp. VIII + 502. $6.50.

Life Science is a textbook intended for use in a general biology course in college. It is lucidly written and copiously illustrated. The presentation of the material is rather new. Anatomy and physiology are nicely interwoven. Man and the application of the various biological processes to man are emphasized whenever it is feasible. At the end of each chapter there is a well chosen reading list. This reviewer is of the opinion that Life Science would be a better balanced text if the botanical subject matter which it contains were amplified.

Hillary J. Kline, C.S.Sp.
Dept. of Biology
Duquesne University

Pomp and Pestilence

• *By* RONALD HARE, M.D. New York. Philosophical Library. 1955. Pp. 224. $5.75.

This is a fascinating book. It is in no way sensational, yet there is not a page that does not capture and maintain the interest of the reader.

The subtitle "Infectious Disease, its History and Conquest" adequately describes the scope of this work. The author, a professor of bacteriology at St. Thomas' Hospital in London, has succeeded in presenting this vast subject in a comprehensive, brief and scientifically accurate fashion. The opening chapter explains the basic concepts necessary for the understanding of infectious disease, such as infection, contagion, paracitism, etc. The subsequent chapters deal with the history of infectious disease and their conquest. The bibliography is excellent.

This book should be included in the general education reading list for college freshmen, and can be highly recommended for the high school library. It will be found to be of interest not only to students and scientists but to all who are interested in human progress. *J. P. M.*

General Principles of Geology

• *By* J. F. KIRKALDY. New York. Philosophical Library. 1955. Pp. 327. $6.00.

This book is an introduction to the basic principles of geology. It is well written and its presentation of basic concepts is excellent. It covers physical geology and geomorphology, petrology and mineralogy, the composition and origin of the earth, historical geology and economic geology. It has eighty-four excellent diagrams and eleven tables. Any beginner can acquire a good introductory knowledge of geology from this text.

American readers, who are unacquainted with the physical geography of England, Scotland and Wales, will find some difficulty with this book, as almost all the author's examples are taken from the British Isles. However, aside from this weakness it is an excellent introduction to geology. *J. P. M.*

Conserving Natural Resources

• *By* SHIRLEY W. ALLEN. New York: McGraw-Hill Book Co. 1955. Pp. x — 348. $5.50.

This college textbook on the conservation of natural resources is excellent in its coverage, presentation and accuracy. The author, without losing sight of the political, social and economic aspects of conservation practice, covers the entire field of renewable and nonrenewable natural resources. This work is not just another textbook but a much needed contribution to the literature on the conservation of natural resources.

This book should be studied by all who have an intelligent interest in the welfare of our country. For, unless the public realizes the importance of conservation of natural resources no conservation policy can succeed.

High school science teachers, on whom a considerable share of the burden of conservation education falls, cannot afford to pass up this book.

The text is pleasing in appearance, well bound and well printed. Over one hundred and sixty well-chosen illustrations and a large number of charts, maps and graphs not only clarify the author's discussions but add greatly to the attractiveness of the book. *J. P. M.*

Awards for Students in Science and Mathematics

During the coming school year, 140 students throughout the nation will share awards totalling $10,000 in the fifth annual program of Science Achievement Awards. The program is conducted by the Future Scientists of America of the National Science Teachers Association (an NEA department).

The contest is open to all students in grades 7 through 12 in public, private, and parochial schools. Awards consisting of U. S. Savings Bonds, gold pins, certificates, and school trophy plaques will be given for outstanding projects. Honorable mention awards will be granted to several hundred additional students. Equal awards will be given in each of eight geographic regions. The National Association of Secondary-School Principals has placed this contest on the Approved List of National Contests and Activities for 1955-56.

Any project—an investigative problem, a library research, model building, etc.—in general science, biology, chemistry, physics, or any field of science or mathematics at any grade level (7 through 12) is eligible for entry. Special national awards will be given for projects that deal with metals or metallurgy. Project reports must be mailed to Regional Chairman not later than March 15.

The Science Achievement Awards program is sponsored by the American Society for Metals, an organization of professional metallurgical engineers. To participate, students are expected simply to complete and report a science or mathematics project; there are no tests to take and no essays to write. Awards are designed to give recognition for individual student activity and accomplishment and to encourage students to consider careers in science and engineering.

Additional information and student entry forms may be obtained from the Future Scientists of America, National Science Teachers Association, 1201 Sixteenth St., N.W., Washington 6, D. C.

Titles of representative winning projects in the 1955 program of Science Achievement Awards included the following: "The Direct Conversion of Solar Radiation into Electricity"; "How We See Depth"; "What Happens When The Antennae of Insects Are Cut?"; "Spark Testing Metals"; "Geometry in Design"; "Microchemical Analysis of Ore Minerals."

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Malvinia Schweizer
New York University

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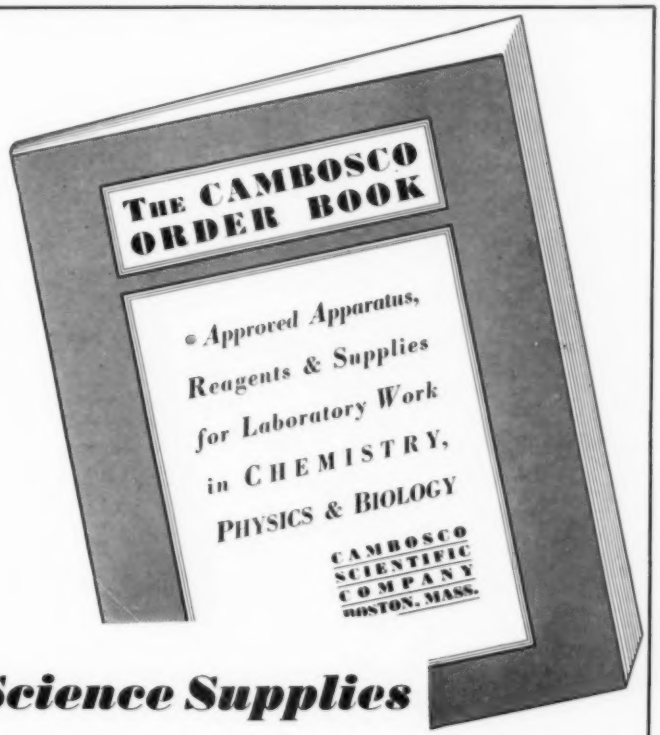
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